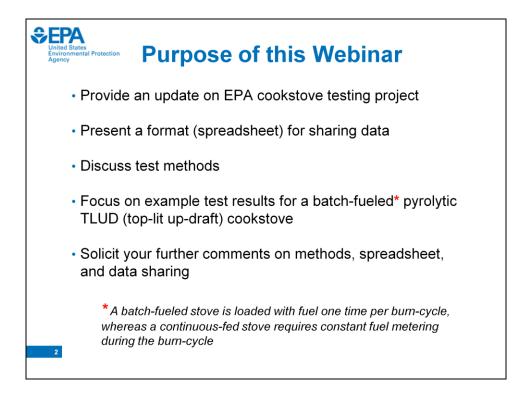


Thanks to Ranyee and the Global Alliance for Clean Cookstoves for hosting this webinar. Thank you all for joining us, and thank you for sending in your questions and comments. We will respond to as many questions as we can today, and if we can't get to them all, we will follow-up and respond to all comments received before, during, and after the webinar. Your input is valuable to us, and we appreciate the continued discussion.

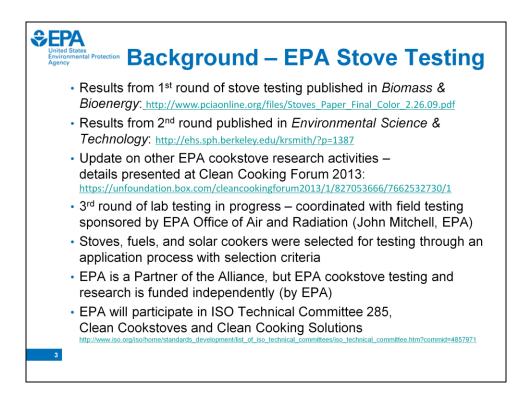
Disclaimers:

 This presentation has been reviewed and approved by the U.S. Environmental Protection Agency, but the views expressed are those of the authors and do not necessarily reflect the views or policies of the U.S. EPA.

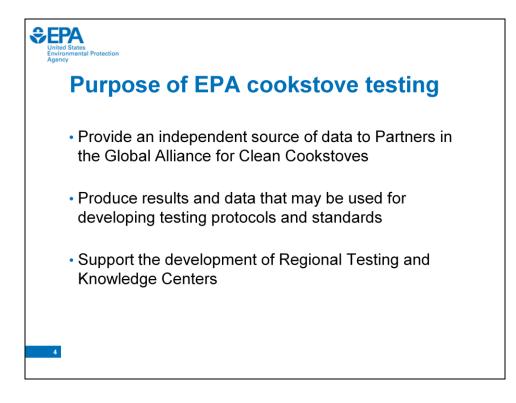
2. Mention of trade names or commercial products does not constitute endorsement or recommendation for use.



The purpose of this webinar is to give you an update on our cookstove testing project. Some of you have expressed your interest in our test data (including raw data), as well as test results, so we are presenting a spreadsheet format for sharing data for your review and comments. We want to discuss test methods, especially for batch-fueled stoves, because we have found these stoves are challenging to test. After the webinar today, we will post the recorded session, the presentation slides with notes, and the spreadsheet for your further comments. The first part of this webinar will be on stove testing issues that may be of more broad interest to many of you, and the second part will focus on the spreadsheet that may be of more narrow interest to some of you.



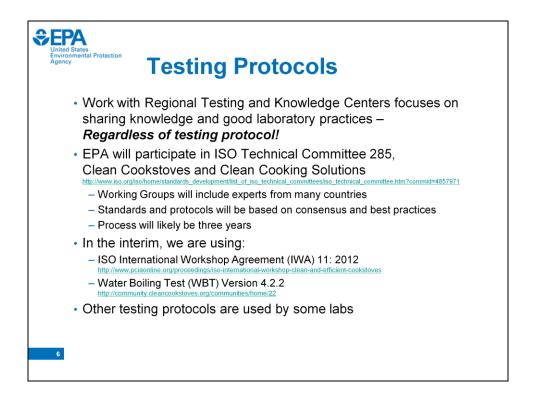
Here is some very brief background information. We conducted two previous rounds of testing, and results were published in scientific journal articles in 2009 and 2012 – links are provided for your information. If you are interested in more details on other EPA stove research activities, please see the link to the presentation from the recent Clean Cooking Forum. We are currently in the middle of a third round of laboratory testing that is coordinated with field testing sponsored by EPA's Office of Air and Radiation and led by John Mitchell. Update from John ....



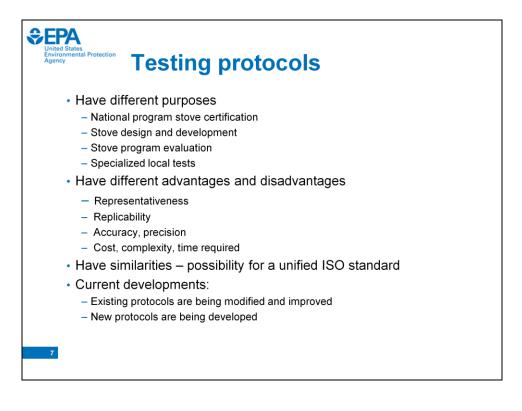
The purpose of our cookstove testing is to provide an independent source of data to Partners of the Alliance. We hope our test results, data, and experience will be useful for developing testing protocols and standards. We support the development of the Regional Testing and Knowledge Centers – some of the Centers are sponsored by the Alliance.



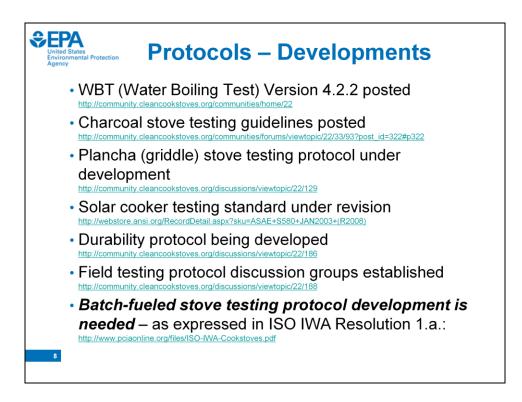
In support of the Regional Testing and Knowledge Centers, we conducted a week-long Intensive Training Workshop at our laboratory in North Carolina this year. The Workshop was sponsored and co-hosted by the Alliance. We had 42 great participants from 16 different countries – they were scientists, engineers, and stove testers from many of the Regional Centers. Faculty included folks from EPA, Berkeley Air Monitoring Group, Colorado State University, Aprovecho Research Center, University of Illinois, Food and Fuel Consultants, and the SeTAR Centre. There were classroom sessions and laboratory activities in the EPA Cookstove Testing Facility. The Alliance will sponsor a series of cookstove testing workshops at rotating locations. EPA was honored to host the first workshop to support the development of the network of Centers. For more information, please see the links for training materials and for a communiqué that was issued by the participants.



Our work with the Regional Testing Centers focuses on sharing knowledge and good practices – Regardless of the testing protocol that is used! As John discussed, we will participate in the ISO process to develop standards and test protocols for stoves. At first, the ISO process seemed a bit complicated to me, but now I understand that the real technical work of developing and drafting standards and protocols will be done by Working Groups that will be inclusive of experts from many countries. Standards and protocols will be based on consensus and best practices. The timeline is likely to be three years, beginning sometime after the first ISO meeting in November. We are testing stoves now, and we can't wait for three years for a final standard. So in the interim, we are using the guidelines from the ISO IWA and the Water Boiling Test protocol – links are provided. There are different water boiling test protocols, but when we refer to the Water Boiling Test (or the WBT) in this webinar, we are referring to the version specified here. Other testing protocols are used by some labs. Many of us stove testers share a burning desire to do good work, but we don't always agree with each other on the best approaches. Sometimes we disagree, but when we take time to carefully consider each others' viewpoints and data, we learn from each other, and we advance the science and art of stove testing. I've heard from some people who feel that stove testing is changing too quickly and it's difficult to keep up with all the changes, but then I've heard from others who feel frustrated that things are not changing fast enough. The ISO process will take time, but I think it gives us the best opportunity we've ever had to advance stove testing!



Various existing test protocols have different purposes or combinations of purposes. Protocols have different advantages and disadvantages, such as those listed here, and these are some of the factors that may be considered in the ISO process. Despite the differences between protocols, there are many similarities, and I believe there is a good opportunity for developing a unified ISO standard based on consensus protocols. There are ongoing developments – existing protocols are being modified and improved, and new protocols are being developed.



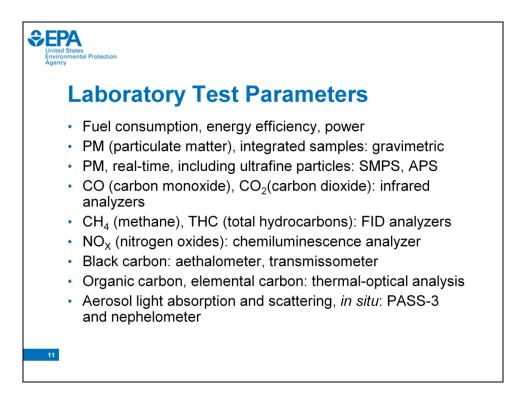
On protocol developments – the most recent Water Boiling Test version is posted, and the spreadsheet continues to be developed with input from users. Experimental guidelines for testing charcoal stoves were recently developed by an ad hoc working group formed at this year's Clean Cooking Forum. A plancha stove testing protocol is under development by a group of stakeholders. A solar cooker testing standard is under revision. A stove durability protocol is being developed. Field testing protocol discussion groups have been established. More information is available from the links. All of these efforts and many more developments may feed into the ISO process. Lastly, there is a need for a testing protocol for batch-fueled stoves. This need was expressed in a Resolution in the IWA, and this need is one of the reasons we are holding this webinar.



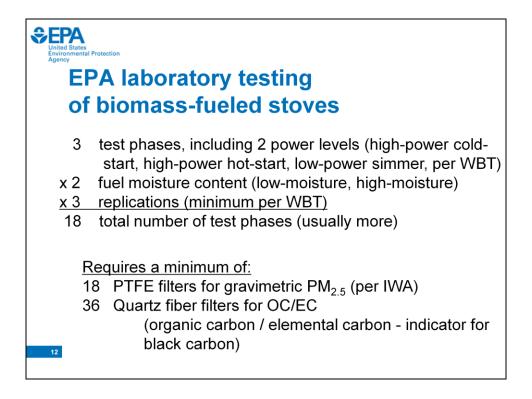
This photo shows stoves we are currently testing. Stoves listed in bold text are batch-fueled with wood. The stove shown inside the red circle is the one we will focus on in this webinar. It is a batch-fueled pyrolytic TLUD (top-lit up-draft) type cookstove. Thanks to Karsten Bechtel and CREEC in Uganda for permission to use preliminary results for the Mwoto stove for discussion purposes today and for review of the spreadsheet.



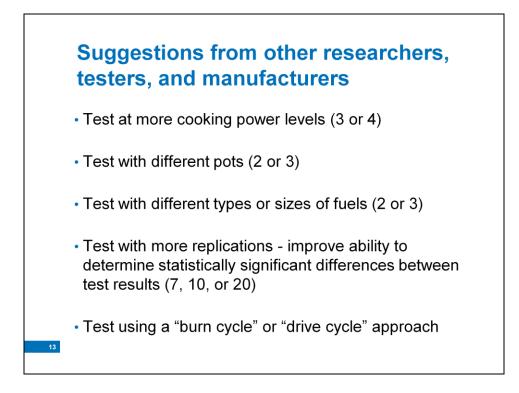
Along with testing cookstoves, we are also evaluating three types of solar cookers, and Seth is working on a publication that will include results.



In the laboratory, we are measuring fuel consumption, energy efficiency, power, and emissions of air pollutants listed here. The IWA guidelines specify that measurements of only carbon monoxide and particulate matter are required for rating stoves for emissions, but we are measuring emissions of additional pollutants that may affect human health and the environment. We are measuring gaseous and particulate pollutants in real-time, as well as in some integrated measurements.



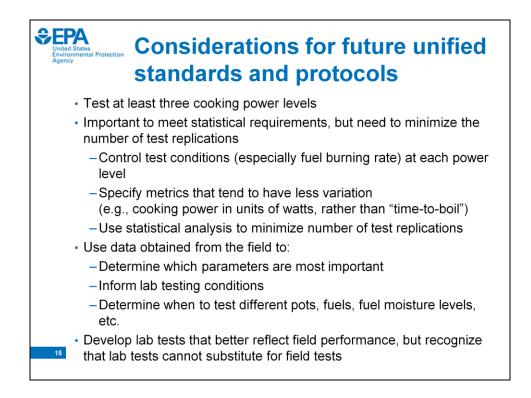
The Water Boiling Test protocol has three test phases that include two power levels – there is a high-power cold-start, a high-power hot-start, and a low-power simmer. We test most biomass-fueled stoves with two fuel-moisture levels, and we perform at least three replications, as specified in the WBT. The total number of test phases then is at least 18, and this requires at least 18 filters for gravimetric analysis of particulate matter. Gravimetric analysis is specified in the IWA, because it is the most reliable way to measure emissions of PM mass. Analyzing a separate filter for each test phase provides useful data during different operating conditions. Filters must be carefully weighed before and after testing, and it is a time-consuming process. For each test phase, we also use two quartz fiber filters for determining organic carbon and elemental carbon in particulate matter, so we analyze at least 36 quartz filters for each stove/fuel combination. This OC/EC analysis is also a time-consuming process.



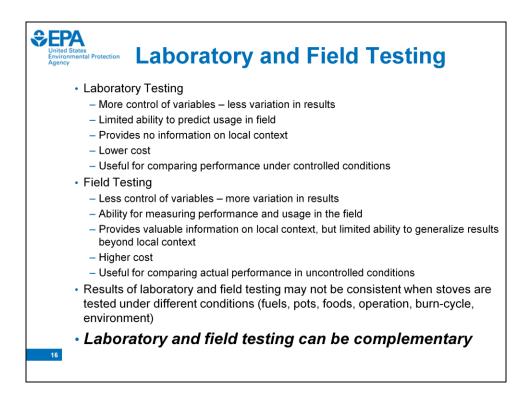
We have heard many good suggestions for how we could expand stove testing in the future, and a few are listed here. We could test at more cooking power levels – we usually test at two power levels, as specified in the WBT, but we've published results that show the value of testing at more than two levels. An example of another stove-testing protocol that uses multiple power levels is the standard test for EPA-certified heating stoves in the United States - it requires four power levels. We've heard suggestions for three or four power levels for testing cookstoves. Other suggestions are that - we could test with more than one pot. We could test with different types, species, sizes, or shapes of fuel. We could test with more replications to improve the ability to determine statistically significant differences between test results. The number of replications needed depends on specifics of the test, but more than one research group has suggested that we generally need more replications than 3, and the numbers suggested for testing typical biomass-fueled stoves have been 7, 10, or as many as 20. Other researchers have suggested we could test using a "burn cycle" or "drive cycle" approach that would enable the lab test conditions to be more reflective of actual field conditions, and that could improve the correlation between lab and field test results.

United States Environmental Prot Agency	Challenge of practical implementation in future stove testing
	Suggestions:
	- Test at more power levels (3 or 4)
	- Test with different pots (2 or 3)
	- Test with different types or sizes of fuels (2 or 3)
	- Test with more replications ( <b>7</b> , 10, or 20)
Now	With all suggestions included
3	4 test phases (including <b>3</b> power levels)
x 2	x 2 fuel moisture content
	x 2 fuel (types or sizes)
	x 2 pot sizes
<u>x 3</u>	x 7 replications
18	224 total number of test phases
	Filters peeded with all auggestions included:
	Filters needed with all suggestions included: 224 Filters for gravimetric PM <sub>2.5</sub>
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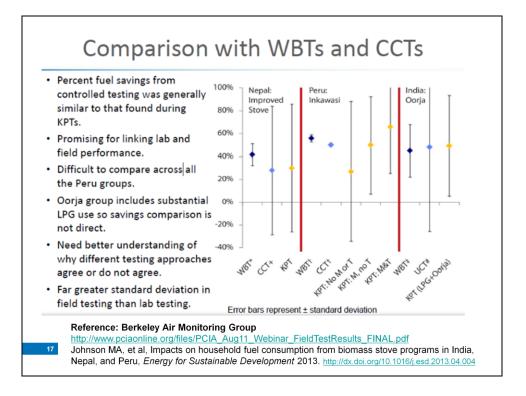
I think all of these suggestions (and some others) are good ideas, and I think many of these ideas may be incorporated in unified stove testing protocols developed through the ISO process. I think a challenge for us will be to come to a consensus on how we can integrate the best ideas in a test protocol that will be practical for testing centers to use on a routine basis. I think the example outlined in this slide illustrates the challenge. If we tested with just one more cooking power level, with two different pots, with two types of fuel, and with 7 replications, we would have a total number of test phases that would be impractical for a routine test. But we have a smart, creative, and diverse group of scientists, engineers, and stove testers from many countries who will be working on this challenge through the ISO process, and I think we can and will come to a consensus on practical unified standards and protocols.



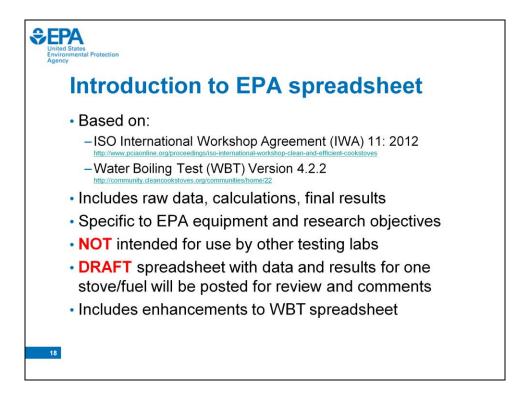
There will be many more considerations for developing standards and protocols, but here are some that I think are important. I think it is a very good idea to test at least three cooking power levels. I think it is essential to meet statistical requirements, but I think we need to minimize the number of test replications, and I think we can do that by carefully controlling the test conditions (especially the fuel burning rate) at each power level tested. This is easy for some stoves (such as LPG stoves), but it is a challenge for other stoves that are more difficult to control. We can specify metrics that tend to have less variation – for example, we can specify cooking power in units of watts, rather than using the familiar "time-to-boil" that typically has a larger variation than cooking power. We can use statistical analysis to minimize the number of test replications needed. I think we can use data from the field to determine which parameters are most important, to inform lab testing conditions, and to determine when to test different pots, fuels, and fuel moisture levels. I think we can develop lab tests that better reflect field performance, but I think we must recognize that lab tests cannot substitute for field tests.



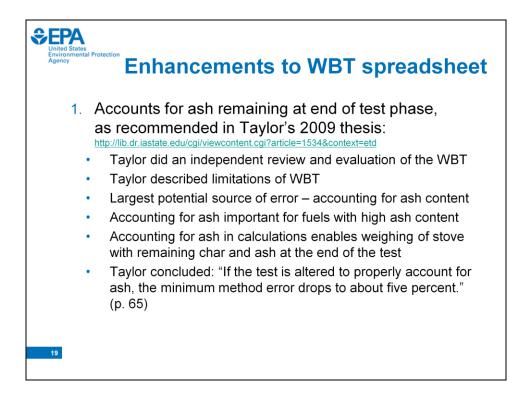
When we test stoves in the laboratory, we have more control over variables and less variation in results, compared to testing done in the field. But lab tests have very limited ability to predict how stoves are actually used in the field. The lab test provides no information on the local context, but if we have information from the field, we can better simulate field performance in the lab. Lab tests generally cost less than field tests, because field tests typically require larger sample sizes for statistical significance. Lab tests are better for comparing performance under controlled conditions, while field tests are better for comparing actual performance in uncontrolled conditions. There are many examples of disagreement between lab and field test results for stoves, but when we look at those examples, we find that stoves were tested under very different conditions in the lab and field. If we test under similar conditions, we should get similar results. On the other hand, when we test stoves under more ideal conditions in the lab, that testing can also have value, because if a stove does not perform well in a lab test, it is unlikely to perform any better in the field, and we can test a stove at lower cost in the lab before conducting field trials. The bottom line is that laboratory and field testing are both needed and can be complementary.



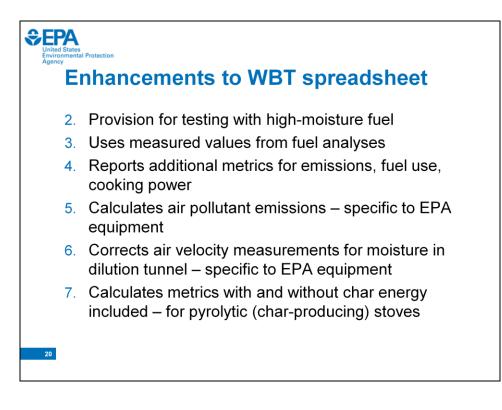
I think this slide beautifully illustrates the potential for lab and field tests to be complementary. Thanks to Michael Johnson and Berkelev Air Monitoring Group for permission to use this slide – the reference at the bottom includes a link to the recent publication of these results. This slide shows percent fuel savings for three different stoves tested in three different countries (the red bars separate the three different cases). The WBTs are the lab tests, the CCTs are the Controlled Cooking Tests, and the KPTs are the Kitchen Performance Tests that are done in the field. The error bars show variation in terms of plus or minus one standard deviation. Results from lab and field tests are generally similar, and the lab tests have less variation. In the Peru case, the KPT field testing provides additional valuable information – results show that fuel savings increased with stove maintenance and training (denoted by the M & T at the bottom of the chart) – this is the kind of information that is impossible to get with lab testing. I think most of us would agree with the comment on this slide that we need better understanding of why different testing approaches agree or do not agree. I think we are more likely to see agreement between lab and field tests for stoves that use processed fuels and for stoves that require less attention and manipulation by the user, but many other factors are involved.



And now let's introduce our EPA spreadsheet – it is based on the IWA and the WBT. It includes the raw data, calculations, and final results. The spreadsheet is specific to EPA equipment and research purposes, and it is NOT designed for use by other testing labs. A DRAFT spreadsheet with data and results for the Mwoto stove will be posted for your review and comments. Since the results for this stove are not finalized, please do not quote or cite the results. Included in the EPA spreadsheet are some enhancements to the WBT. Some of these enhancements might be considered in the next revision of the WBT or in other protocols that are developed.



I will describe seven enhancements to the WBT spreadsheet. First, we account for ash remaining at the end of each test phase, as recommended in Taylor's 2009 Master's thesis – a link is provided. At Iowa State University, Taylor did an independent review and evaluation of the Water Boiling Test. He described limitations of the WBT, and he found that the largest potential source of error is in failing to address the ash content in the material remaining in the stove at the end of the test phase. The error is small with fuels (such as wood) with relatively small ash content, but the error can be large with fuels (such as charcoal, some crop residues, and dung) with relatively large ash content. The error may be minimized if the ash can be physically separated from unburned fuel and char, but this is difficult with some fuels (such as rice hulls). Accounting for the ash in calculations enables us to get a more accurate measurement of the mass of remaining char when we place the stove with remaining char and ash on an electronic balance at the end of the test. When possible, placing the stove on a balance is easier and faster than dumping out the remaining char and separating the ash. Taylor concluded that "If the test is altered to properly account for ash, the minimum method error drops to about five percent." (p. 65)



These are additional enhancements to the spreadsheet:

2. We test most biomass stoves with both low- and high-moisture fuel. When we test a stove with high-moisture fuel, low-moisture fuel is usually required to start the fire, similar to the way the stove is actually used in the field. Our spreadsheet has calculations for handling fuels with two different moisture contents during the same test.

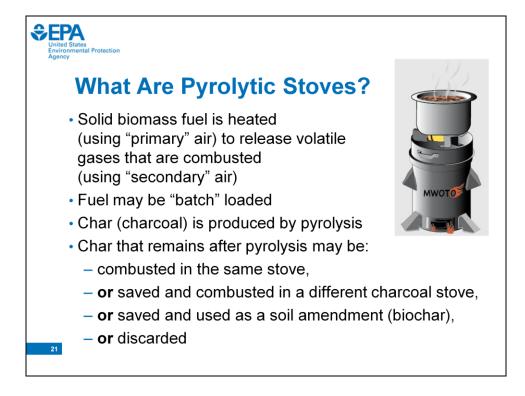
3. We do proximate and ultimate analyses of fuel and remaining char, and we use the measured values in our calculations.

4. We report additional metrics for emissions, fuel use, and cooking power.

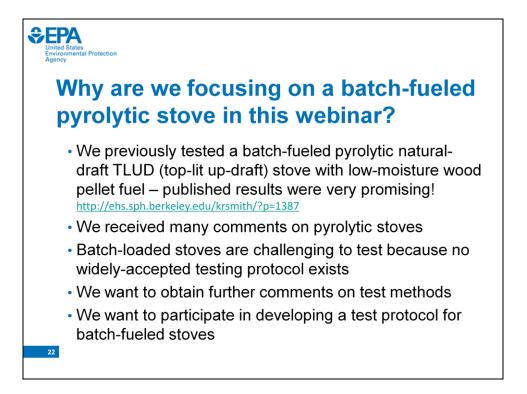
5. Our spreadsheet includes calculations for air pollutant emissions specific to our equipment.

6. We are using the total-capture method for quantifying emissions, so the air velocity measurements in our dilution tunnels are critical. We correct the air velocity for moisture in the air. This correction is small when there is a large ratio of dilution air to emissions, but the correction can be significant when there is a small dilution ratio.

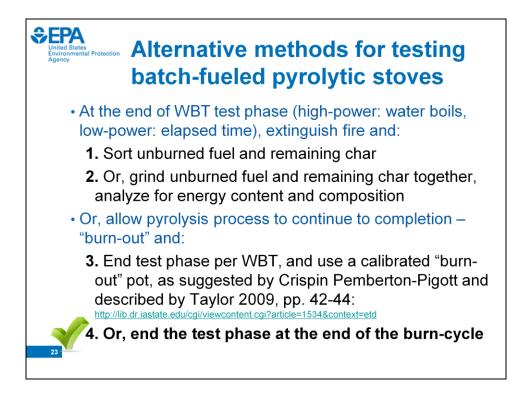
7. We are calculating metrics both with and without the energy of the remaining char included for pyrolytic (or char-producing) stoves. We will discuss this more in a few minutes.



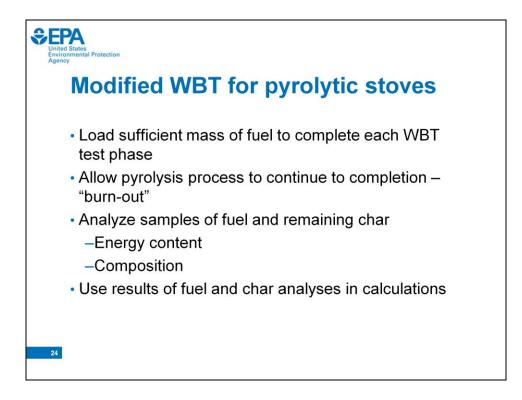
For those of you who are not familiar with pyrolytic stoves, here is a brief description. Solid fuel is heated (using "primary" air) to release volatile gases that are then combusted (using "secondary" air). The pyrolytic stoves we are testing are batch-fueled, but there are some other types of pyrolytic stoves that are fueled continuously. Pyrolysis produces char (or charcoal) that is richer in carbon content than the wood or other biomass fuel that is used in the process. Char that remains after pyrolysis may be combusted in the same stove (if the stove is designed to combust the char), **OR** the char can be saved for fuel and combusted in a different stove (ideally in a stove designed for charcoal fuel), **OR** it can be saved and used for biochar or other purposes, **OR** it may just be discarded and not used for any purpose.



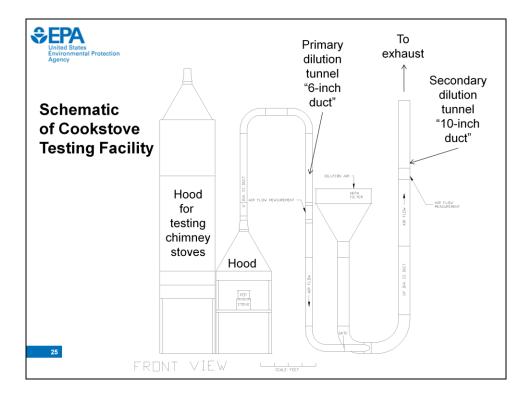
In this webinar, we are focusing on a batch-fueled pyrolytic stove for several reasons. We previously tested a TLUD (top-lit up-draft) stove with low-moisture wood pellet fuel, and we published results that showed the stove had high energy efficiency and low emissions. We have received many comments on pyrolytic stoves, and there has been quite a debate going on between some of our colleagues over charproducing stoves. On one side of the debate are people who are developing or promoting char-producing stoves, and they are concerned that testing may not be adequately capturing the potential benefits of char-producing stoves. On the other side of the debate are people who are concerned that testing may not be adequately capturing the potential losses of efficiency with char-producing stoves. Here at EPA, we appreciate all your comments, and our job is to test stoves and report results in a way that is fair, unbiased, and useful. I'll come back to this topic of testing and reporting efficiency for char-producing stoves a little later in this presentation. Batch-loaded stoves are challenging to test for us, because there is no widely-accepted testing protocol. We want your further comments on test methods and we want to participate in developing a test protocol – possibly through an ISO Working Group.



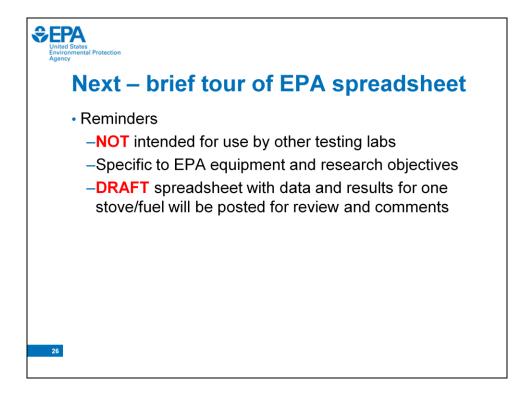
We know of four alternative methods for testing batch-fueled pyrolytic stoves – there may be others or other variations. In Method 1, the fire is extinguished at end of the test phase, and the unburned fuel and remaining char are sorted and separated. We used this method in the past for testing stoves with pellet fuel, but it was tedious to separate the charred and uncharred pellets, and there was uncertainty with partially charred pellets. In Method 2, the fire is extinguished at the end of the test phase, and the remaining char and unburned fuel are collected and ground together to obtain a representative sample that is analyzed for heat of combustion and for composition. This method is certainly more accurate than Method 1, but it requires many fuel samples to be analyzed, because the composition of the char and remaining fuel may be different in each test replication. In Method 3, the test pot is removed at the end of the WBT test phase and is replaced with a calibrated "burn-out" pot. The pyrolysis process is allowed to continue to completion, and the energy that is left in the fuel at the end of the test phase is estimated from energy input to the "burn-out" pot. A link is provided for more details. Method 3 has the advantage of being consistent with the WBT while allowing pyrolysis to continue to completion, so there is no remaining fuel mixed with char at the end of the procedure. We think it is a good idea to allow the pyrolysis process to complete for the entire batch of fuel, because this is how stoves are actually operated in the field. We also think it is a good idea to capture emissions and measure performance over the entire burn-cycle for the batch of fuel, so we are suggesting and using Method 4. In Method 4, the test phase includes the entire burn-cycle - requires modified WBT.



This is a brief description of our suggested modified WBT procedure for pyrolytic stoves. First, we experiment with the stove to determine approximately how much fuel is required to complete each WBT test phase. We think this is consistent with field use, as stove users learn how much fuel to load to complete a cooking task. In the high-power test phases, when the water reaches boiling temperature, we do not immediately stop the test, but we let the test continue until the pyrolysis process completes. We have done experiments that show that we measure the same energy input to the pot whether the water is boiling or not, so it does not matter if the water continues to boil at the end of the test phase. During the low-power test phase, we also allow the pyrolysis process to continue to completion. We analyze samples of fuel and remaining char. Fuel analysis results for remaining char at the end of pyrolysis are consistent between test replications, so fuel analysis is not required for every single test replication.



Before Seth begins showing you the spreadsheet, I want to show you this schematic of our cookstove testing facility. We have two hoods for collecting emissions – one is for testing stoves with tall chimneys, and one is for stoves without chimneys. The system has two dilution tunnels so we can measure air pollutant emissions at different concentrations, depending on the instruments or methods. The primary dilution tunnel has the higher concentration, and Seth may refer to this in the spreadsheet as the "6-inch duct." The secondary dilution tunnel has the lower concentration, and Seth may refer to this as the "10-inch duct."



Next, Seth will give you a brief tour of our DRAFT spreadsheet. I want to remind everyone again that we are not suggesting that other labs use this spreadsheet for testing stoves, because this is specific to our EPA equipment and research purposes. We are making this draft spreadsheet available as a way to share our data and as a way to obtain feedback and comments on our testing. Seth has spent countless hours working on this, and he knows this spreadsheet better than anyone.

Stove Manufacturer & Model     Mwoto Factories Ltd., Uganda; Model 2012 (Serial Number 809)       Testing Center     EPA-RTP       Testing Center     EPA-RTP       Strest Protocol     WBT Version 4.22, EPA Rev. 4       Fuel Used     Red Oak, Average Moisture Content 6.7%, Dimensions: 2 x 2 x 2-7.63 cm       Pot Used     Standard flat-bottom 7L pot w/ St. of water       Test Dates Included in Summary     02/07/2013 02/08/2013 02/12/2013 02/19/2013       These results were obtained in accordance with ISO IWA (International Workshop Agreement) 11: 2012       Metric     Value       Unit     Sub-Tier       Efficiency / Fuel Use     Efficiency       Tier     High Power Thermal Efficiency       2     Metric       Uow Power Specific Energy Consumption     0.043       Migh Power CO     3       8     June Power PM23       9     Cow Power RC1     1       1     Indoor Emissions       2     High Power CO     0.29       4     Low Power RC2     0.043       1     Low Power RC3     1       1     Indoor Emissions     1       2     High Power CO     0.29       3     G     1       4     Low Power RC3     1       5     Uow Power CO     0.15       6	Testing Center         EPA-RTP           Test Protocol         WBT Version 4.2.2, EPA Rev. 4           Fuel Used         Red Oak, Average Molsture Content 6.7%, Dimensions: 2 x 2 x 2-7.63 cm           Pot Used         Standard flat-bottom 7L pot w/5L of water           Test Dates included in Summary         02/07/2013 02/08/2013 02/12/2013 02/19/2013           These results were obtained in accordance with ISO IWA (International Workshop Agreement) 11: 2012           Metric         Value           Unit         Sub-Titer           Efficiency / Fuel Use	1	DRAFT - POR R	EVIEW UNL	TON OUNCE	QUOTE OR CITE					
4       Testing Center       EPA.RTP         5       Test Protocol       WBT Version 4.2.2, EPA Rev. 4         6       Fuel Used       Red Oak, Average Moisture Content 6.7%, Dimensions: 2 x 2 x 2-7.63 cm         7       Pot Used       Standard flat-bottom 7L pot w/ SL of water         8       Test Dates included in Summary       02/07/2013 02/08/2013 02/12/2013 02/13/2013         9       These results were obtained in accordance with ISO IWA (International Workshop Agreement) 11: 2012         10       These results were obtained in accordance with ISO IWA (International Workshop Agreement) 11: 2012         11       Metric       Value       Unit         12       Metric       Value       Unit         13       Efficiency / Fuel Use       9         14       High Power Thermal Efficiency       26       %       2         15       Tier       1       High Power CO       3       g // Mint L       1         16       Emissions	Testing Center         EPA-RTP           Test Protocol         WBT Version 4.2.2, EPA Rev. 4           Fuel Used         Red Oak, Average Molsture Content 6.7%, Dimensions: 2 x 2 x 2-7.63 cm           Pot Used         Standard flat-bottom 7L pot w/5L of water           Test Dates included in Summary         02/07/2013 02/08/2013 02/19/2013           These results were obtained in accordance with ISO IWA (International Workshop Agreement) 11: 2012           Metric         Value           Unit         Sub-Titer           Efficiency / Fuel Use	2 3	Charles for	0.14	dat	Adverte Frederic Ind. Here do be	dal 2012 (Ca	al Number 2000)			
5       Test Protocol       WBT Version 4.2.2, EPA Rev. 4         6       Fuel Used       Red Oak, Average Moisture Content 6.7%, Diemesions: 2 x 2 x 2-7.63 cm         7       Pot Used       Standard flat-bottom 7. pot v/S. 50 water         8       Test Dates included in Summary       02/07/2013 02/08/2013 02/12/2013 02/19/2013         9       These results were obtained in accordance with ISO IWA (International Workshop Agreement) 11: 2012         11       Metric       Value       Unit         12       Metric       Value       Unit         13       Efficiency / Fuel Use       7         14       Tier       1       High Power Thermal Efficiency       26       %       2         15       Tier       2       Kerric       3       8 / Miseivered       4         16       Emissions	Test Protocol         WBT Version 4.2.2, EPA Rev. 4           Fuel Used         Red Oak, Average Molsture Content 6.7%, Dimensions: 2 x 2 x 2-7.63 cm           Pot Used         Standard flat-bottom X, pot w/ 5/s.0 fwater           Test Dates included in Summary         02/07/2013 02/08/2013 02/19/2013           These results were obtained in accordance with ISO IWA (International Workshop Agreement) 11: 2012           Metric         Value           Unit         Sub-Tier           Efficiency / Fuel Use         Value           Tier         High Power Thermal Efficiency         26           Value         Unit         Sub-Tier           Low Power Specific Energy Consumption         0.043         MU / (min L)           Tier         High Power CO         3         g / MJ_asivent           High Power PM3_3         171         mg / Maintus         2           Low Power PM3_3         1         mg / (min L)         4           Indoor Emissions         Img / PM3_2         1         mg / (min L)         4           Low Power PM3_3         15         mg / min         2         Low Power PM3_3         15         mg / min         2           Low Power PM3_3         15         mg / min         3         3         3				idel		odel 2012 (Sei	rial Number 809)			
6         Fuel Used         Red Oak, Average Moisture Content 6.7%, Dimensions: 2 x 2 x 2 - 7.63 cm           7         Pot Used         Standard flat-bottom 7, pot w/ 5L of water           9         Test Dates Included in Summary         02/07/2013 02/08/2013 02/12/2013 02/12/2013           9         These results were obtained in accordance with ISO IWA (International Workshop Agreement) 11: 2012           1         Metric         Value         Unit           12         Metric         Value         Unit         Sub-Tier           14         Tier         1         High Power Thermal Efficiency         26         %         2           16         Emissions         Image Power Specific Energy Consumption         0.043         MJ / (min L)         1           16         Emissions         Image Power PM13         171         mg / Migeivenet         2           16         Indoor Emissions         Image Power PM13         171         mg / (min L)         4           17         Image Power PM13         15         mg / min         4           18         Tier         2         High Power PO         0.04         g / min         4           19         Tier         2         High Power PM13         171         mg / Min         14	Fuel Used         Red Oak, Average Moisture Content 6.7%, Dimensions: 2 x 2 x 2.7.83 cm           Pot Used         Standard flat-bottom 7L pot w/5L of water           Test Dates included in Summary         02/07/2013 02/08/2013 02/19/2013 02/19/2013           These results were obtained in accordance with ISO IWA (International Workshop Agreement) 11: 2012           Metric         Value           Unit         Sub-Tier           Efficiency / Fuel Use         Imp Power Thermal Efficiency           Tier         1           High Power Specific Energy Consumption         0.643           MU / (min L)         1           Emissions         Imp Power CO           Use Power CO         0.043           High Power PM2.3         171           Low Power PM2.3         171           Indoor Emissions         High Power CO           Tier         2           High Power PM2.3         1           Low Power CO         0.29           More PM2.3         1           Indoor Emissions         1           Tier         2           Low Power PM2.3         15           Low Power PM2.3         15           Low Power PM2.3         15           Low Power PM2.3         15			r			-				
Pot Used       Standard flat-bottom 7L pot w/SL of water         Itest Dates included in Summary       02/07/2013 02/08/2013 02/12/2013 02/19/2013         Itest Dates included in Summary       02/07/2013 02/08/2013 02/12/2013 02/19/2013         Itest person in the secondance with ISO IWA (International Workshop Agreement) 11: 2012         Itest results were obtained in accordance with ISO IWA (International Workshop Agreement) 11: 2012         Itest person in the secondance with ISO IWA (International Workshop Agreement) 11: 2012         Itest person in the secondance with ISO IWA (International Workshop Agreement) 11: 2012         Itest person in the secondance with ISO IWA (International Workshop Agreement) 11: 2012         Itest person in the secondance with ISO IWA (International Workshop Agreement) 11: 2012         Itest person in the secondance with ISO IWA (International Workshop Agreement) 11: 2012         Itest person in the secondance with ISO IWA (International Workshop Agreement) 11: 2012         Itest person in the secondance with ISO IWA (International Workshop Agreement) 11: 2012         Itest person in the secondance with ISO IWA (International Workshop Agreement) 11: 2012         Itest person in the secondance with ISO IWA (International Workshop Agreement) 11: 2012         Item in the secondance with ISO IWA (International Workshop Agreement) 11: 2012         Item in the secondance with ISO IWA (International Workshop Agreement) 11: 2012         Item in the secondance with ISO IWA (International Workshop Agreement) <td>Pot Used         Standard flat-bottom 7L pot w/5L of water           Test Dates Included in Summary         02/07/2013 02/08/2013 02/12/2013 02/19/2013           These results were obtained in accordance with ISO IWA (International Workshop Agreement) 11: 2012           Metric         Value           Unit         Sub-Tier           Efficiency / Fuel Use            Tier         1           High Power Thermal Efficiency         26           Signal         %           Uwer Specific Energy Consumption         0.043           MU (min L)         1           Emissions            Tier         1           High Power CO         3           g / MU_{advered}         4           Low Power PM2.a         171           Indoor Emissions            Tier         2           High Power CO         0.29           g / min         4           Indoor Emissions            Tier         2           High Power PM2.a         1           Low Power OD         0.29           g / min         4           Indoor Emissions            Uow Power OD         0.15           <t< td=""><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></t<></td>	Pot Used         Standard flat-bottom 7L pot w/5L of water           Test Dates Included in Summary         02/07/2013 02/08/2013 02/12/2013 02/19/2013           These results were obtained in accordance with ISO IWA (International Workshop Agreement) 11: 2012           Metric         Value           Unit         Sub-Tier           Efficiency / Fuel Use            Tier         1           High Power Thermal Efficiency         26           Signal         %           Uwer Specific Energy Consumption         0.043           MU (min L)         1           Emissions            Tier         1           High Power CO         3           g / MU_{advered}         4           Low Power PM2.a         171           Indoor Emissions            Tier         2           High Power CO         0.29           g / min         4           Indoor Emissions            Tier         2           High Power PM2.a         1           Low Power OD         0.29           g / min         4           Indoor Emissions            Uow Power OD         0.15 <t< td=""><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></t<>										
8         Test Dates included in Summary         02/07/2013         02/107/2013 <td>Test Dates included in Summary         02/07/2013         02/08/2013         02/19/2013         02/07/2013</td> <td></td> <td></td> <td></td> <td>-</td> <td></td> <td></td> <td>ensions: 2 x 2 x 2 -</td> <td>7.63 cm</td> <td></td>	Test Dates included in Summary         02/07/2013         02/08/2013         02/19/2013         02/07/2013				-			ensions: 2 x 2 x 2 -	7.63 cm		
9       These results were obtained in accordance with ISO IWA (International Workshop Agreement) 11: 2012         11       Metric       Value       Unit       Sub-Tier         12       Efficiency / Fuel Use       Imp Power Thermal Efficiency       26       %       2         13       Efficiency / Fuel Use       Imp Power Thermal Efficiency       26       %       2         14       Tier       1       High Power Thermal Efficiency       26       %       2         16       Emissions       Imp Power Specific Energy Consumption       0.043       MU / (min L)       1         18       Tier       2       High Power CO       3       g / Missivend       4         19       Indoor Emissions       Imp / Ower PM13       171       mg / (min L)       4         21       Indoor Emissions       Imp / Ower PM13       15       mg / min       4         22       Tier       2       High Power CO       0.29       g / min       4         22       Tier       2       High Power PM13       15       mg / min       2         23       Tier       2       High Power PM13       15       mg / min       3       3         24       Tier       2	These results were obtained in accordance with ISO IWA (International Workshop Agreement) 11: 2012       Metric     Value     Unit     Sub-Tier       Efficiency / Fuel Use       Tier     1     Migh Power Thermal Efficiency     26     %     2       Tier     1     Migh Power Thermal Efficiency     26     %     2       Low Power Specific Energy Consumption     0.043     MJ / (min L)       Emissions       Tier     2     Low Power CO     0.043     MJ / (min L)       Low Power CO     0.043     g / Mightweet       Migh Power PM23     171     mg / Mightweet       Low Power PM23     1     mg / min L       Image: Colspan="2">Colspan="2">Colspan="2">Colspan="2">Colspan="2">Colspan="2">Colspan="2">Migh Power PM23       Tier     2       Low Power CO     0.29     g / min 4       High Power PM23     15     mg / min 2       Low Power PM23     15 <th c<="" td=""><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></th>	<td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td>									
Image: Problem in the second and equivalent dry fuel consumed)       These results were obtained in accordance with ISO IWA (International Workshop Agreement) 11: 2012         Image: Problem in the second and equivalent dry fuel consumed)       The results were obtained in accordance with ISO IWA (International Workshop Agreement) 11: 2012         Image: Problem in the second and equivalent dry fuel consumed)       Tier       Image: Problem in the second and equivalent dry fuel consumed)         Image: Problem in the second and equivalent dry fuel consumed)       Problem in the second and equivalent dry fuel consumed)       Image: Problem in the second and equivalent dry fuel consumed)         Image: Problem in the second and equivalent dry fuel consumed)       Problem in the second and equivalent dry fuel consumed)       Problem in the second and equivalent dry fuel consumed)       Problem in the second and equivalent dry fuel consumed)         Image: Problem in the second and transfer to the second and equivalent dry fuel consumed)       Problem in the second and the second andit second andition and the second and the second and	Metric         Value         Unit         Sub-Tier           Efficiency / Fuel Use         High Power Thermal Efficiency         26         %         2           Tier         1         High Power Specific Energy Consumption         0.043         MU / (min L)         1           Emissions		Test Dates Incl	luded in Su	mmary	02/07/2013 02/08/2013 02/12/20	13 02/19/201	5			
Index       Metric       Value       Unit       Sub-Tier         Image: Second Seco	Metric         Value         Unit         Sub-Tier           Efficiency / Fuel Use         High Power Thermal Efficiency         26         %         2           Tier         1         High Power Specific Energy Consumption         0.043         MU / (min L)         1           Emissions		Those results	wara abtair	ad in accor	dance with ISO IMA (International)	Markshop Am	nomont) 11: 2012			
Image: space	Efficiency / Fuel Use           Tier         1         High Power Thermal Efficiency Low Power Specific Energy Consumption         0.043         MU / (min L)         1           Emissions         High Power CO         3         g / MJ <sub>abivend</sub> 4           Tier         2         High Power CO         0.044         g / (min L)         4           Indoor Emissions         Indoor Emissions         Img / MJ <sub>abivend</sub> 2         1         mg / MJ <sub>abivend</sub> 2           Indoor Emissions         Img / Power PM <sub>2.3</sub> 1         mg / (min L)         4         4           Tier         2         High Power CO         0.29         g / min         4           Low Power CO         0.15         g / min         4         10           Low Power PM <sub>2.5</sub> 15         mg / min         2           Low Power PM <sub>2.5</sub> 4         mg / min         3	11	These results i	were obtain	ied in accor	dance with ISO IWA (International	workshop Agi	eementj 11: 2012			
Efficiency / Fuel Use         Image: High Power Thermal Efficiency       26       %       2         Image: High Power Specific Energy Consumption       0.043       MJ / (min L)       1         Image: High Power CO       3       g / Mideweed       4         Image: High Power CO       0.044       g / (min L)       4         Indoor Emissions       Image: High Power CO       0.29       g / min       4         Image: High Power CO       0.29       g / min       4       1         Image: High Power CO       0.29       g / min       4       1         Image: High Power CO       0.29       g / min       4       1         Image: High Power CO       0.29       g / min       4       1         Image: High Power PM2.5       15       mg / min       2         Image: High Power PM2.5       15       mg / min       3         Image: High Power PM2.5	Efficiency / Fuel Use           Tier         1         High Power Thermal Efficiency Low Power Specific Energy Consumption         0.043         MU / (min L)         1           Emissions         High Power CO         3         g / MJ <sub>abivend</sub> 4           Tier         2         High Power CO         0.044         g / (min L)         4           Indoor Emissions         Indoor Emissions         Img / MJ <sub>abivend</sub> 2         1         mg / MJ <sub>abivend</sub> 2           Indoor Emissions         Img / Power PM <sub>2.3</sub> 1         mg / (min L)         4         4           Tier         2         High Power CO         0.29         g / min         4           Low Power CO         0.15         g / min         4         10           Low Power PM <sub>2.5</sub> 15         mg / min         2           Low Power PM <sub>2.5</sub> 4         mg / min         3	12			Matric		Value	Unit	Sub-Tier		
High Power Thermal Efficiency         26         %         2           Image: Second S	Tier         1         High Power Thermal Efficiency         26         %         2           Low Power Specific Energy Consumption         0.043         MU / (min L)         1           Emissions	13	Efficiency	/ Fuel Us			Volue	ont	Jub-mer		
Iter         I         Low Power Specific Energy Consumption         0.043         MJ / (min L)         1           Emissions         Image: Specific Energy Consumption         0.043         MJ / (min L)         1           Emissions         Image: Specific Energy Consumption         0.043         MJ / (min L)         1           Image: Specific Energy Consumption         0.043         MJ / (min L)         1           Image: Specific Energy Consumption         0.043         g / Migelweed         4           Image: Specific Energy Consumption         0.043         g / Migelweed         4           Image: Specific Energy Consumption         0.043         g / Migelweed         4           Image: Specific Energy Consumption         0.043         g / Migelweed         4           Image: Specific Energy Consumption         0.043         g / Migelweed         4           Image: Specific Energy Consumption         0.043         g / Min         4           Image: Specific Energy Consumption         10.04         g / Min         4           Image: Specific Energy Consumption         0.15         g / min         4           Image: Specific Energy Consumption         10.15         mg / min         3           Image: Specific Energy Construl Hotstart Phases)         W	High Power CO         0.043         MJ / (min L)         1           Emissions         High Power CO         3         g / MJ_aliverd         4           Tier         2         High Power CO         0.043         MJ / (min L)         1           Indoor Emissions         Img / MJ_aliverd         4         Mg / MJ_aliverd         4           Indoor Emissions         Img / MJ_aliverd         1         mg / MJ_aliverd         2           Indoor Emissions         Img / MJ_aliverd         1         mg / MJ_aliverd         2           Low Power PM_{2.5}         1.71         mg / Min L)         4           High Power CO         0.29         g / min         4           Low Power CO         0.15         g / min         4           Low Power PM_{2.5}         1.5         mg / min         2           Low Power PM_{2.5}         4         mg / min         3	14			-	ver Thermal Efficiency	26	%	2		
Image: second	Emissions         High Power CO         3         g / MJ_polymed         4           Low Power CO         0.04         g / (min 1)         4           High Power PM23         171         mg / MJ_polymed         2           Low Power PM23         171         mg / (min 1)         4           Indoor Emissions         1         mg / (min 1)         4           Tier         2         Low Power PM23         1         mg / (min 1)         4           Indoor Emissions         1         mg / (min 1)         4         4           Low Power CO         0.29         g / min         4           Low Power CO         0.15         g / min         4           Low Power PM23         15         mg / min         2           Low Power PM23         4         mg / min         3	15	Tier	1							
Image: space	Tier         High Power CO         3         g / MJ_alvend         4           Low Power CO         0.04         g / (min 1)         4           High Power PM23         171         mg / MJ_alvend         2           Low Power PM23         171         mg / MJ_alvend         2           Low Power PM23         1         mg / (min L)         4           Indoor Emissions              Tier         2         Low Power CO         0.29         g / min         4           High Power CO         0.15         g / min         4           High Power PM23         15         mg / min         2           Low Power PM23         15         mg / min         3		Emissions		LOW POW	er specific Energy consumption	0.045	wo / (mm c)	1		
Image: Second	Tier         2         Low Power CO High Power PM23         0.04         g/(min 1)         4           Indoor Emissions         171         mg/MJaelueet         2           Low Power PM2.3         1         mg/(min L)         4           Indoor Emissions	17	Linissions		High Dow	ver CO	2	g/MI	4		
Index         Z         High Power PM25         171         mg / Milestivest         2           Indoor Emissions         Low Power PM25         1         mg / (min L)         4           Indoor Emissions         Image (min L)         4         Image (min L)         4           Tier         Z         High Power CO         0.29         g / min         4           Image (min L)         Migh Power CO         0.15         g / min         4           Uw Power PM25         15         mg / min         2           Low Power PM25         15         mg / min         2           Cooking Power (average of Cold Start and Hot Start phases)         W         1427           Fuel burning rate (average of Cold Start, based on equivalent dry fuel consumed)         g / min         16.4           Fuel burning rate (average for Kart, based on equivalent dry fuel consumed)         g / min         19.8           Fuel burning rate (average for Simmer, based on equivalent dry fuel consumed)         g / min         5.6	High Power PM25         171         mg/ MJselveved         2           Low Power PM25         1         mg/ (min L)         4           Indoor Emissions              Tier         2         Image PM25         1         mg/ (min L)         4           Indoor Emissions                Tier         2         High Power CO         0.29         g/min         4           Low Power CO         0.15         g/min         4           High Power PM25         15         mg/min         2           Low Power PM23         4         mg/min         3	250									
Indoor Emissions         If         mg / Macound         2           Indoor Emissions         Low Power PM <sub>2.5</sub> 1         mg / (min l.)         4           Indoor Emissions         Image: Im	High Power PM23         171         mg/ MUseurese         2           Low Power PM23         1         mg/ (min L)         4           Indoor Emissions         4         4           Tier         Aigh Power CO         0.29         g/ min         4           Image (min L)         4         4         4         4           Image (min L)         4         15         mg (min L)         4           Image (min L)         4         15         10         10         10           Low Power PM23         4         15         10         10         10	18	Tier	2							
Indoor Emissions         High Power CO         0.29         g/min         4           22         Low Power CO         0.15         g/min         4           24         Tier         2         High Power CO         0.15         g/min         4           24         Low Power PM123         15         mg/min         2         15         mg/min         2           26         Low Power PM123         15         mg/min         3         2         16	Indoor Emissions         Image: Constraint of the second seco	19		-			171	mg / MJ <sub>delivered</sub>	2		
122         High Power CO         0.29         g/min         4           123         Tier         2         Low Power CO         0.15         g/min         4           124         High Power PM123         15         mg/min         2           125         Low Power PM23         4         mg/min         2           126         Low Power PM23         4         mg/min         3           126         Cooking Power (average of Cold Start and Hot Start phases)         W         1427           128         Fuel burning rate (average of Cold Start, based on equivalent dry fuel consumed)         g/min         16.4           129         Fuel burning rate (average for Hot Start, based on equivalent dry fuel consumed)         g/min         13.8           130         Fuel burning rate (average for Simmer, based on equivalent dry fuel consumed)         g/min         3.6	Tier         High Power CO         0.29         g/min         4           Low Power CO         0.15         g/min         4           High Power PM25         15         mg/min         2           Low Power PM25         4         mg/min         3	20			Low Pow	er PM <sub>2.5</sub>	1	mg / (min L)	4		
23         Tier         2         Low Power CO         0.15         g/min         4           24         Low Power PM13         15         mg/min         2           25         Low Power PM23         15         mg/min         2           26         Low Power PM23         4         mg/min         3           26         Cooking Power (average of Cold Start and Hot Start phases)         W         1427           28         Fuel burning rate (average of Cold Start, based on equivalent dry fuel consumed)         g/min         16.4           29         Fuel burning rate (average for Cold Start, based on equivalent dry fuel consumed)         g/min         16.4           30         Fuel burning rate (average for Simmer, based on equivalent dry fuel consumed)         g/min         15.5	Tier         2         Low Power CO High Power PM25         0.15         g/min         4           Low Power PM25         15         mg/min         2           Low Power PM25         4         mg/min         3	21	Indoor Em	issions							
Part         Low Power PM2.5         15         mg / min         2           Low Power PM2.5         4         mg / min         3           Low Power PM2.5         4         mg / min         3           Cooking Power (average of Cold Start and Hot Start phases)         W         1427           Part Puel burning rate (average of Cold Start, based on equivalent dry fuel consumed)         g / min         16.4           Puel burning rate (average for Cold Start, based on equivalent dry fuel consumed)         g / min         16.8           Fuel burning rate (average for Simmer, based on equivalent dry fuel consumed)         g / min         5.6	Life         Z         High Power PM25         15         mg / min         2           Low Power PM23         4         mg / min         3	22			High Pow	ver CO	0.29	g/min	4		
High Power YM25         15         mg/min         2           Low Power PM25         4         mg/min         3           66	High Power PM25         15         mg / min         2           Low Power PM25         4         mg / min         3	23	Tion	2	Low Pow	er CO	0.15	g/min	4		
26     Cooking Power (average of Cold Start and Hot Start phases)     W     1427       27     Evel burning rate (average of Cold Start, based on equivalent dry fuel consumed)     g / min     16.4       29     Fuel burning rate (average for Cold Start, based on equivalent dry fuel consumed)     g / min     19.8       30     Fuel burning rate (average for Simmer, based on equivalent dry fuel consumed)     g / min     5.6		24	Tier	2	High Pow	ver PM <sub>2.5</sub>	15	mg/min	2		
27     Cooking Power (average of Cold Start and Hot Start phases)     W     1427       28     Fuel burning rate (average for Cold Start, based on equivalent dry fuel consumed)     g / min     16.4       29     Fuel burning rate (average for Hot Start, based on equivalent dry fuel consumed)     g / min     19.8       30     Fuel burning rate (average for Simmer, based on equivalent dry fuel consumed)     g / min     9.6		25			Low Pow	er PM <sub>2.5</sub>	4	mg/min	3		
Fuel burning rate (average for Cold Start, based on equivalent dry fuel consumed)         g/min         16.4           Puel burning rate (average for Hot Start, based on equivalent dry fuel consumed)         g/min         19.8           Fuel burning rate (average for Simmer, based on equivalent dry fuel consumed)         g/min         19.8           Fuel burning rate (average for Simmer, based on equivalent dry fuel consumed)         g/min         9.6		26	-								
Puel burning rate (average for Hot Start, based on equivalent dry fuel consumed)         g/min         19.8           80         Fuel burning rate (average for Simmer, based on equivalent dry fuel consumed)         g/min         9.6	Cooking Power (average of Cold Start and Hot Start phases) W 1427	27	Cooking Powe	r (average	of Cold Star	t and Hot Start phases)		w	1427		
Fuel burning rate (average for Simmer, based on equivalent dry fuel consumed) g / min 9.6	Fuel burning rate (average for Cold Start, based on equivalent dry fuel consumed) g / min 16.4	28	Fuel burning n	ate (averag	e for Cold S	tart, based on equivalent dry fuel o	onsumed)	g/min	16.4		
Fuel burning rate (average for Simmer, based on equivalent dry fuel consumed) g / min 9.6	Fuel burning rate (average for Hot Start, based on equivalent dry fuel consumed) g / min 19.8	29	Fuel burning r	ate (averag	e for Hot St	art, based on equivalent dry fuel co	insumed)	g/min	19.8		
		30							9.6		
	B	31		(are/ug		,		87.0007			
		32									

-Following are "screen shots" from the EPA – WBT spreadsheet

-Will be made available later on Alliance site

-Summary worksheet (tab circled) presents results in format specified in ISO IWA guidelines

Stove	lanufact.	irer & Mo	del	Mwoto Factories Ltd., Uganda; M	odel 2012 (Ser	al Number 2001		
Testing		itel & MU	uei	EPA-RTP	Juei 2012 (Seli	an Number 803)		
Test Pro				WBT Version 4.2.2, EPA Rev. 4				
Fuel Use	ed			Red Oak, Average Moisture Cont	ent 6.7%, Dime	ensions: 2 x 2 x 2-1	7.63 cm	
Pot Use	d			Standard flat-bottom 7L pot w/ 5	of water			
Test Dat	tes Includ	ded in Sur	nmary	02/07/2013 02/08/2013 02/12/20	13 02/19/2013			
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-Starting at the top of the sheet

-Important-to-define test conditions: descriptions of stove, fuel, pot, and loading

-All info on sheet filled automatically to minimize possibility of typographical errors

Efficiency / Fuel Use         Mathematical Strategy         26         52           Tier         1         10         10         2           Emissions         1         10         10         1           Tier         1         10         10         1         1           Image: State Stat		DRAFT - FOR RE	VIEW ONI	Y - DO NOT	QUOTE OR CITE			
4       The strong Constant       SCA 1970         5       And 1 is decided       With 1 wears and 2.5 MSA 1974 (rest. 1974), Strongerstown, 2.5 A.2 A.3 7745 (rest. 1974), Strongerstown, 2.5 A.3 7745 (rest. 1974), Strongerstown, 2.5 A.3 7745 (rest. 1974), Strongerstown, 2.5 A.2 A.3 7745 (rest. 1974), Strongerstown, 2.5 A.3 7745 (rest. 1974),	2							1
5         Control Protocol         Math Protocol         Math Protocol         Math Protocol           6         Least Stated         Least Sta								
6         Left field         Ref Chick Alverage Midesterer Content 6.7% (International Vorkshop Agreement) 11: 2012           7         Test results were obtained in accordance with ISO IWA (International Workshop Agreement) 11: 2012           9         These results were obtained in accordance with ISO IWA (International Workshop Agreement) 11: 2012           10         These results were obtained in accordance with ISO IWA (International Workshop Agreement) 11: 2012           12         Mr           14         Tier           15         Tier           16         Emissions           17         Hi           18         Tier           19         These results were obtained in accordance with ISO IWA (International Workshop Agreement) 11: 2012           18         Efficiency / Fuel Use           14         Tier           10         Prover 500         5           10         Prover 500         5         2/Milesce           10         Prover 500         5         2/Milesce           10         Prover 500         5         2/Milesce           11         Lie Rever 500         5         2/Milesce           12         Indoor Emissions         1         1         1           14         Prover 500         5.25								
Test transfer         Description         Description <thdescription< th=""> <thdescription< th=""></thdescription<></thdescription<>	C							
8       Prescheduleret instrumment       Description results       Description results         9       These results were obtained in accordance with ISO IWA (international Workshop Agreement) 11: 2012         11       These results were obtained in accordance with ISO IWA (international Workshop Agreement) 11: 2012         12       MM       Results       Addition       Addition       Addition         12       MM       Results       Addition       Addition       Addition       Addition         13       Efficiency / Fuel Use       MM       Results and the statement of t	10111 (							
9         1           10         These results were obtained in accordance with ISO IWA (International Workshop Agreement) 11: 2012           12         Me         1           12         Me         1           13         Efficiency / Fuel Use         1           14         Tier         1         1           15         Tier         1         10           16         Emissions         1         2           17         1         10         2         2           18         Tier         1         10         2         2           19         Tier         4         10         2         2           10         Tier         4         2         4         2           10         Tier         4         2         2         2         2           10         Tier         4         2         2         2         2         4         2           10         Foreer 6%         5         5         1         4         2           22         Tier         4         2         2         2         2         4         2         4         2         4<								1
Index     These results were obtained in accordance with ISO IWA (International Workshop Agreement) 11: 2012       Image: state of the stat								
Indoor Emissions         Hi         Power SD         6.23         g/min         4           Indoor Emissions         Indoo		These results w	vere obtai	ned in accor	dance with ISO IWA (Internation	al Workshop Ag	reement) 11: 2012	
Hit         Efficiency / Fuel Use           14         Tier         1         Hit         Prevent Themail Effectioncy         28         %         2           15         Tier         1         Hit         Prevent Specific Energy Consumption         0.042         Att 2 (mm, t)         3           16         Emissions         4         Prevent Specific Energy Consumption         0.042         Att 2 (mm, t)         3           17         Tier         2         1         Prevent SS         1         4         4         4           19         Tier         2         1         Prevent SS         0.042         9         4         4           19         Tier         2         1         Prevent SS         0.04         2         2           20         Indoor Emissions         1         Prevent SS         1         4         4           21         Indoor Emissions         1         Prevent SS         0.05         0.05         1         4           22         Tier         2         Hit         Prevent SS         0.05         0.05         1         4           23         Tier         2         Prevent SS         0.05         0.05		incoc results in	icic obtai			ar tronishop rig.		
14         Tier         1         Hu         Pergent Thermal Efficiency         2E         N         2           15         Emissions         6         Percent Speech classery Consumption         0.005         M/7 (mm.s)         3           16         Emissions         1         1         Percent Speech classery Consumption         0.005         M/7 (mm.s)         3           17         Tier         2         d / Microwski         4         Microwski         4           18         Tier         2         d / Microwski         4         Microwski         4           19         Tier         2         Hi         Percent Mage         33         mg? //min1         4           21         Indoor Emissions         1         Percent RMage         3         org ?/min1         4           23         Tier         2         Hi         Percent RMage         33         p.?/min1         4           24         Tier         2         Hi         Percent RMage         33         mg?/min1         3           25         Emissions         1         Percent RMage         33         mg?/min1         3           24         Tier         2         Mit	12			Method				
14         Tier         1         Her         Pergent Thermal Efficiency         26         N         2           15         Emissions         0.005         0.	13	Efficiency /	Fuel U	se				
Hier         Lo         Beneric Strengt Consumption         O.842         Att / (mint)         2           16         Emissions	4	1		High Pos				
Image: Second	Cont.	Tier	1					
17         18         17         18         21         10<		Emissions		LU				
18         Tier         2         10         Power 60         0.04         profession         3           19         Indoor Emissions		LINISSIONS						-
19         11er         2         Hit         Recover RMay         311         Ind/ Museum         22           20         Indoor Emissions	200							-
Index     Image: Marging and	18	Tier	2					
21     Indoor Emissions       22     High Prevention       23     Tier       24     Prevention       25     Image Prevention       26     Image Prevention       27     Cooling Preventioner (severage of Coold Start, based on equivalent dry fuel constrained)     Image Prevention       28     Cooling Preventioner (severage of Coold Start, based on equivalent dry fuel constrained)     Image Prevention       28     Cooling Preventioner (severage for Coold Start, based on equivalent dry fuel constrained)     Image Prevention       29     Fuel barring rate (severage for coold Start, based on equivalent dry fuel constrained)     Image Prevention       30     Fuel barring rate (severage for coold Start, based on equivalent dry fuel constrained)     Image Prevention	19	, iici j	-	High Post				
Hi         Perver SD         0.25         g/min         4           23         Tier         2         6         5	20			Low Pow				
23         Tier         2         Iso Prover 2MLs         6.15         p.f.min         4           24         Tier         2         Iso Prover 2MLs         25         mg / mu         2           25         Iso Prover 2MLs         4         mg / mu         2           26         Test Borning rate (swerage of Cold Start, and Het Start phase)         W         1427           26         Test Borning rate (swerage for Cold Start, David on equivalent by fuel consumed)         g / min         18/2           29         Fuel borning rate (swerage for Cold Start, David on equivalent by fuel consumed)         g / min         18/2           29         Fuel borning rate (swerage for Cold Start, David on equivalent by fuel consumed)         g / min         18/2           30         transitioning rate (swerage for Start, based on equivalent by fuel consumed)         g / min         36.8	21	Indoor Emi	ssions					
23         Tier         2         Iso Prover 2MLs         6.15         p.f.min         4           24         Tier         2         Iso Prover 2MLs         25         mg / mu         2           25         Iso Prover 2MLs         4         mg / mu         2           26         Test Borning rate (swerage of Cold Start, and Het Start phase)         W         1427           26         Test Borning rate (swerage for Cold Start, David on equivalent by fuel consumed)         g / min         18/2           29         Fuel borning rate (swerage for Cold Start, David on equivalent by fuel consumed)         g / min         18/2           29         Fuel borning rate (swerage for Cold Start, David on equivalent by fuel consumed)         g / min         18/2           30         transitioning rate (swerage for Start, based on equivalent by fuel consumed)         g / min         36.8	22			High Rev				
24         Tier         2         Hit Revert Mdgs         33         mg / mm         2           25         Lo         Percent PMgs         4         mg / mm         2           26         Lo         Percent PMgs         4         mg / mm         2           26         Lo         Percent PMgs         4         mg / mm         3           27         Cooking Prover (seerage of Cold Start, Nexed on equivalent by foel constrmed)         g / min         182           28         Full burning rate (seerage for Cold Start, based on equivalent by foel constrmed)         g / min         184           29         Full burning rate (seerage for Cold Start, based on equivalent dry foel constrmed)         g / min         184           30         transforming rate (seerage for cold Start, based on equivalent dry foel constrmed)         g / min         34		_	_					
Low Power PML2s         4         mg / min         3           26		Tier	2					
25     27     Coluting Prover (seenage of Cold Start, and Hot Start phases)     W     3427       28     Fund borning rate (seenage of Cold Start, based on equivalent dry foel consumed)     g/min     36.4       29     Fund borning rate (average for Cold Start, based on equivalent dry foel consumed)     g/min     36.8       30     Fund borning rate (average for Striner, based on equivalent dry foel consumed)     g/min     36.8	200							
27         Cooking Prover (seenage of Cold Start, and Rot Start, phase)         W         1427           28         Fund borning rate (seenage of Cold Start, backed on equivalent dry fund consumed)         g/ min         36.4           29         Fund borning rate (seenage for Cold Start, backed on equivalent dry fund consumed)         g/ min         36.8           30         Fund borning rate (seenage for Striner, backed on equivalent dry fund consumed)         g/ min         36.8				LOWEROW				1
28         Fund sources previous for Cold Start, based on equivalent dry fuel consumed)         g/min         364           29         Fuel burning rate (average for Hot Start, based on equivalent dry fuel consumed)         g/min         3bal           30         tractitioning rate (average for Hot Start, based on equivalent dry fuel consumed)         g/min         3bal		Contraction and the	(Balling 1997)	100				1
29         Fuel borning rate (average for Hot Start, bused on equivalent day fuel consumed)         g/min         30.8           30         ruel borning rate (average for Striner, based on equivalent day fuel consumed)         g/min         3.8								
30 Euel burning rate (average for Stmmer, based on equivalent dry fuel consumed) ig / min 1:500								
	29							
	30							
	32 33 • • • •		-					

-Next section down

-Tier values on left (as defined by the IWA) . . .

	508.85	C		E QUOTE OR CITE	F	G	n	1
DRAFT	FOR RE	VIEW ONL	T-DONOT	QUOTE OR CITE	-		_	-
Stores A								1
1 Testing								
5 Test Pr								
Fuel We								
Pot Use								
the second se								1
0 These r	esults w	vere obtair	ned in accor	dance with ISO IWA (Internationa	I Workshop Ag	reement) 11: 2012		
2					Value	Unit	Sub-Tier	1
and the second s					TOTOL		000 1101	1
4					26	%	2	1
• 5 Ti					0.043	MJ / (min L)	1	1
6 Emiss								
7					3	g / MJ <sub>delivered</sub>	4	1
8					0.04	g/(min L)	4	1
9					171	mg / MJ <sub>delivered</sub>	2	1
0					1	mg / (min L)	4	1
1 Indoa								1
2					0.29	g/min	4	1
3					0.15	g/min	4	1
4					15	mg/min	2	1
5					4	mg/min	3	1
6								
7 Cookin								
8 Filier bio								
9 Fülel bo								
0 Evel bu								
1								
2				15	100			

-Next section down (continued)

-And sub-tier on right. Provided to help would-be users decide if stove meets their needs based on evaluations of individual characteristics

	DRAFT - FOR F	EVIEW ON	Y - DO NOT	QUOTE OR CITE				
2	_	_						
4								
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25 26								
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27				t and Hot Start phases)		w	1427	
28		and the second data was not in	and the second statement of the se	tart, based on equivalent dry fuel o		g/min	16.4	
29				art, based on equivalent dry fuel co		g/min	19.8	
30 31	Fuel burning r	ate (averag	e for Simme	er, based on equivalent dry fuel con	nsumed)	g/min	9.6	

-In the final section:

-Report cooking power in units of watts (rather than reporting "time-to-boil") and fuel burning rates (to facilitate test replication)

A B	B C	D	E	F	G	Н	1	J	K	L	M	N
1	WATER BOILING TEST	- VERSION 4.2.2 - EPA VER	SION 4									
2	All white cells are linke	d to data worksheets, no en	tries are re	quired								
3					Comments:							
4					DRAFT - FOR	REVIEW ONL	Y - DO NOT	QUOTE OR C	CITE			
5	Stove type/model	Mwoto Model 2012			Test 4 not inc	cluded becau	use air contro	ol was left op	en as an exp	eriment - re	sulting in a fu	uel burn
6	Fuel Type	Red Oak					an the other					
7	Average Fuel Moisture	6.85%										
8												
9												
10												
11	1. HIGH POWER TEST	(COLD START)	units	Test 1	Test 2	Test 3	Test 4	Test 5	Test 6	Average	St Dev	CoV
12	Test date			02/07/13	02/08/13	02/12/13	02/19/13	01/00/00	01/00/00			
13	Test time			12:51:45	12:45:45	10:52:30	10:52:00	0:00:00	0:00:00	N=	3	
14	Include this test in calc	ulations?		yes	yes	yes	no	0.00.00			•	
15	Moisture Level	diations	%	6.66	6.80	7.11	6.04	0.00	0.00	6.85	0.23	3%
16	Fuel consumed (moist)			682.1	530.7	644.9	643.7	0.00	0.00	619.2	78.9	13%
17	Equivalent dry fuel consu	mod	g	458.4	373.7	438.4	436.0	0.0	0.0	423.5	44.3	10%
18	Thermal efficiency	meu	9 %	25.0%	27.1%	28.2%	28.1%	0.0%	0.0%	26.7%	1.6%	6%
19	Burning rate		a/min	17.9	13.8	17.4	21.1	0.0%	0.0%	16.4	2.2	14%
20	Specific fuel consumption		g/liter	95.5	84.4	92.9	92.6	0.0	0.0	90.9	5.8	6%
21	Temp-corr sp fuel consur		g/liter	90.3	86.5	87.7	88.6	0.0	0.0	88.2	1.9	2%
22	Temp-corr sp energy con		kJ/liter	1662	1593	1615	1630	0	0.0	1623	35	2%
23	Fire power		watts	5498	4247	5328	6473	0	0.0	5024	679	14%
24	Cooking power		watts	1373	1149	1500	1818	0	0.00	1341	178	13%
25	Carbon Balance (% differ	ence based on fuel C)	%	5.7	-11.7	-13.5	-13.1	0.0	0.0	-6.5	10.6	
26	Modified combustion effic	iency		0.994	0.985	0.987	0.977	0.000	0.000	0.989	0.005	0%
27												
28				yes	yes	yes	no	-	- 1	N=	3	
29	THC total mass		g	0.42	1.23	1.12	2.09	0.00	0.00	0.92	0.44	48%
30	Temp corr THC total mas		g	0.40	1.27	1.05	2.00	0.00	0.00	0.91	0.45	50%
31	THC per effective volume		g/L	0.08	0.29	0.22	0.43	0.00	0.00	0.20	0.10	53%
32	THC per fuel mass (mois		g/kg	0.61	2.33	1.73	3.25	0.00	0.00	1.56	0.87	56%
33	THC per fuel mass (equiv	<ul> <li>dry fuel basis)</li> </ul>	g/kg	0.91	3.30	2.55	4.80	0.00	0.00	2.25	1.22	54%
34	THC per fuel energy		g/MJ	0.05	0.18	0.14	0.26	0.00	0.00	0.12	0.07	54%
35	THC per energy delivered	to pot	g/MJ	0.20	0.66	0.49	0.93	0.00	0.00	0.45	0.23	52%
36	THC per time		g/hr	0.98	2.74	2.65	6.08	0.00	0.00	2.13	0.99	47%
37											•	
38			-	yes	yes	yes	no	-	-	N=	3	440/
39 40	CO total mass Temp corr CO total mass		g	3.06 2.89	7.24	7.26	12.65 12.10	0.00	0.00	5.86 5.72	2.42	41% 43%
			g a/L	2.89	1.68	0.80	2.57	0.00	0.00	5.72	0.57	43%
	CO per effective volume of Sun mary CS-Result	HS-Result Simmer-Result	General Inform					Test-6	0.001	1.24	0.57	45%

- On next tab, note "CS-Result" circled

-This and the next two sheets provide detailed results for the three WBT test phases – cold start, hot start, and simmer

-The 'Results' tabs put key parameters (measurements) in one place to evaluate all test replications

A B	C	D	E	F	G	H	1	J	K	L	М	N
1	WATER BOILING TEST	- VERSION 4.2.2 - EPA VER	SION 4									
2	All white cells are linked	l to data worksheets, no en	tries are re									
3					Comments:							
4					DRAFT - FOR	REVIEW ONL	Y - DO NOT	QUOTE OR C	ITE			
5	Stove type/model	Mwoto Model 2012			Test 4 not inc	cluded becau	ise air contro	I was left op	en as an exp	eriment - re	sulting in a f	uel burni
6	Fuel Type	Red Oak					an the other t					
7	Average Fuel Moisture	6.85%										
8												
9												
10				-								
11	1. HIGH POWER TEST (	COLD START)	units	Test 1	Test 2	Test 3	Test 4	Test 5	Test 6	Average	St Dev	CoV
12	Test date			02/07/13	02/08/13	02/12/13	02/19/13	01/00/00	01/00/00			
13	Test time			12:51:45	12:45:45	10:52:30	10:52:00	0:00:00	0:00:00	N=	3	
14	Include this test in calcu	detions 2						0.00.00	0.00.00		•	
		liations?		yes	yes c.co	yes	no					
15	Moisture Level		%	6.66		7.11	6.04	0.00	0.00	6.85	0.23	3%
16	Fuel consumed (moist)		g	682.1	530.7	644.9	643.7	0.0	0.0	619.2	78.9	13%
17	Equivalent dry fuel consur	ned	g	458.4	373.7	438.4	436.0	0.0	0.0	423.5	44.3	10%
18	Thermal efficiency		%	25.0%	27.1%	28.2%	28.1%	0.0%	0.0%	26.7%	1.6%	6%
19	Burning rate		g/min	17.9	13.8	17.4	21.1	0.0	0.0	16.4	2.2	14%
20	Specific fuel consumption		g/liter	95.5	84.4	92.9	92.6			90.9	5.8	2%
21 22	Temp-corr sp fuel consun		g/liter kJ/liter	90.3	86.5 1593	87.7 1615	88.6 1630	0.0	0.0	88.2	1.9 35	2%
22	Temp-corr sp energy con: Fire power	sumpt.	watts	1662	4247	5328	6473	0	0.0	1623 5024	679	2%
23	Cooking power			5498 1373	4247	1500	1818	0	0.00	1341	178	14%
24 25	Cooking power Carbon Balance (% differe		watts	1373	-11.7	-13.5	-13.1	0.0	0.00	-6.5	1/8	13%
25 26	Modified combustion effici		70	0.994	-11.7	-13.5	-13.1	0.00	0.000	-0.5	0.005	0%
20	Modified combustion effici	ency		0.994	0.985	0.987	0.977	0.000	0.000	0.989	0.005	0%
28				yes	ves	ves	no			N=	3	
20 29	THC total mass			0.42	1.23	1.12	2.09	0.00	0.00	0.92	0.44	48%
30	Temp corr THC total mas		g	0.42	1.23	1.05	2.09	0.00	0.00	0.92	0.44	50%
31	THC per effective volume		g/L	0.40	0.29	0.22	0.43	0.00	0.00	0.91	0.45	53%
32	THC per fuel mass (moist		g/L g/kg	0.08	2.33	1.73	3.25	0.00	0.00	1.56	0.10	56%
33	THC per fuel mass (moist THC per fuel mass (equiv		g/kg	0.01	3.30	2.55	4.80	0.00	0.00	2.25	1.22	54%
34	THC per fuel energy	ary root basisy	g/kg g/MJ	0.05	0.18	0.14	0.26	0.00	0.00	0.12	0.07	54%
35	THC per energy delivered	to not	g/MJ	0.20	0.66	0.49	0.93	0.00	0.00	0.45	0.23	52%
36	THC per time	to por	g/m3 g/hr	0.20	2.74	2.65	6.08	0.00	0.00	2.13	0.23	47%
37	inte per unie		Sug	0.00	2.14	2.50	0.00	0.00	0.00	2.10	0.00	-17 /
38				yes	yes	yes	no			N=	3	
39	CO total mass		g	3.06	7.24	7.26	12.65	0.00	0.00	5.86	2.42	41%
40	Temp corr CO total mass		g	2.89	7.42	6.86	12.10	0.00	0.00	5.72	2.47	43%
41	CO per effective volume o	f water boiled	g/L	0.60	1.68	1.45	2.57	0.00	0.00	1.24	0.57	45%
	H Sunmary CS-Result	HS-Result Simmer-Result	General Inform					Test-6				

-In this example:

-Four CS test replications were performed for this stove...

B	C	D	E	F	G	Н	1	J	K	L	M	N
	WATER BOILING TEST -	VERSION 4.2.2 - EPA VER	RSION 4									
	All white cells are linked	to data worksheets, no en	tries are re									
				10.00	Comments:							
				4	DRAFT - FOR	REVIEW ONL	Y - DO NOT	QUOTE OR O	ITE			
	Stove type/model	Mwoto Model 2012			Test 4 not in	cluded becau	ise air contro	I was left op	en as an exp	periment - res	ulting in a fu	uel burnir
	Fuel Type	Red Oak			rate that w	vas higher th	an the other t	tests				
	Average Fuel Moisture	6.85%										
						_						
	1. HIGH POWER TEST (C	COLD START)	units	Test 1	Test 2	Test 3	Test 4	Test 5	Test 6	Average	St Dev	CoV
	Test date			02/07/13	02/08/13	02/12//3	02/19/13	01/00/00	01/00/00			
	Test time			12:51:45	12:45:45	10:52 30	10:52:00	0:00:00	0:00:00	N=	3	
	Include this test in calcul	ations?		yes	yes	yes	no					
	Moisture Level		%	6.66	6.80	7.11	6.04	0.00	0.00	6.85	0.23	3%
	Fuel consumed (moist)		g	682.1	530.7	644.	643.7	0.0	0.0	619.2	78.9	13%
	Equivalent dry fuel consum	ed	g	458.4	373.7	438.4	436.0	0.0	0.0	423.5	44.3	10%
ř.	Thermal efficiency		%	25.0%	27.1%	28.2%	28.1%	0.0%	0.0%	26.7%	1.6%	6%
	Burning rate		g/min	17.9	13.8	17.4	21.1	0.0	0.0	16.4	2.2	14%
1	Specific fael consumption		o Steel	95.6	84.4	00.0	00.0	0.0	0.0	00.0	5.8	000
	Temp-corr sp fuel consum											
	Cemp-corr spienergy cons											
	Fire power											
	Cooking power											
	Carbon Balance (% offeres											
	Voolfied combustion efficie											
8												
2	THC total mass											
	Terris corr THC total mass											
	GHC per effective volume o											
	BHO per fuel mass (moint)											
	THC per fuel mass (equiv											
	THC per fuel energy											
	THG per energy delivered to											
	THC per time											
2												
	CO total mass											
)	temp court of the	C										
• •	N Sunmary CS-Result	HS-Result Simmer-Result	General Inform	nation Te	st-1 Test-2	Test-3 Test	4 Test 5	Test-6	0.001			
		Strate Surrentesur	oundra antoin		10002	10000 / 1650	in the search of the	10300				
1	34											

-In this example:

-Results from the fourth replication were excluded from the final average,

-air control was left open (as an experiment), and the fuel burning rate (Row 19 highlighted) was too high

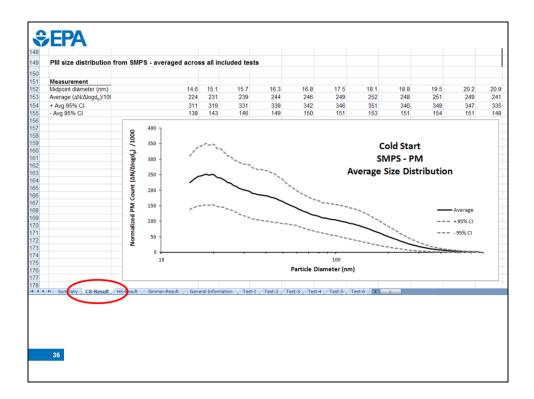
B		D	E	F	G	н	1	J	К	L	М	N
		VERSION 4.2.2 - EPA VER										
	All white cells are linked	to data worksheets, no en	tries are re		Comments:							
-					DRAFT - FOR							
-	a									nasan es		
	Stove type/model Fuel Type	Mwoto Model 2012 Red Oak			Test 4 not in		an the other		en as an exp	enment - res	suiting in a t	Jei burnin
-	Average Fuel Moisture	6.85%			rate triat v	ras nigher un	an the other i	lesis				
	Average i dei moisture	0.0070										
	1. HIGH POWER TEST (C	OLD START)	units	Test 1	Test 2	Test 3	Test 4	Test 5	Test 6	Average	St Dev	CoV
	Test date			02/07/13	02/08/13	02/12/13	02/19/13	01/00/00	01/00/00		-	
	Test time			12:51:45	12:45:45	10:52:30	10:52:00	0:00:00	0:00:00	N=	3	
	Include this test in calcul	ations?		yes	yes	yes	no					
	filmentary transf		in second	,	)	,	ne	0.00	0.00	6.85	6.22	- 100
5	Funiconsumed (most)											
7	Equestient dry fuel consum											
3	Thormal efficience											
	Burrillig nate											
	Specific fuel consumption											
	Temp-corr sp luel consum											
2	emp-corr spienergy consi											
8	Hite power											
5	Cooking power											
3	Lodilied combuston efficie											
7	AND DATE OF A MILLION OF A DISC.											
3				yes	ves	ves	no			N=	3	
	THC total mass		g	0.42		1.12	2.09	0.00	0.00	0.92	0.44	48%
)	Temp corr THC total mass		g	0.40	1.27	1.05	2.00	0.00	0.00	0.91	0.45	50%
	THC per effective volume of		g/L	0.08	0.29	0.22	0.43	0.00	0.00	0.20	0.10	53%
2	THC per fuel mass (moist)		g/kg	0.61	2.33	1.73	3.25	0.00	0.00	1.56	0.87	56%
8	THC per fuel mass (equiv.	dry fuel basis)	g/kg	0.91	3.30	2.55	4.80	0.00	0.00	2.25	1.22	54%
1 5	THC per fuel energy	a nat	g/MJ	0.05		0.14	0.26	0.00	0.00	0.12	0.07	54% 52%
3	THC per energy delivered to THC per time	o pot	g/MJ g/hr	0.20	2.74	2.65	6.08	0.00	0.00	2.13	0.23	47%
7	ino per une		grif	0.98	2.14	2.00	0.08	0.00	0.00	2.13	0.99	4170
3				ves	ves	ves	no			N=	3	
3	CO total mass		g	3.06	7.24	7.26	12.65	0.00	0.00	5.86	2.42	41%
)	Temp corr CO total mass		g	2.89	7.42	6.86	12.10	0.00	0.00	5.72	2.47	43%
	CO per effective volume of Summary CS-Result	water boiled	a/L	0.60	1.68	1.45	2.57	0.00	0.00	1.24	0.57	45%
<b>( )</b>		IS-Result / Simmer-Result /	General Inform	nation Tes	st-1 / Test-2 /	Test-3 Test	4 Test-5	Test-6	ill in the second se			10000
	35											

-Results for THC (total hydrocarbons) and some CO (carbon monoxide) emissions are shown at the bottom of the sheet

-Since we chose to exclude Test 4 (for cold-start phase) all of the results for Test 4 are excluded

- Results for other air pollutant emissions are available by scrolling down on this sheet

-emissions measurements listed by Jim in earlier slide



- On same tab scrolled to the bottom of the worksheet (CS-Result tab circled)
- Average particle size distribution during test phase is shown
- Individual size distributions are provided for each test replication
- -one scan every 2.5 minutes, in raw data sheets covered later

	A B	С	D	E	F G F	H	J K	L	М	N (	O P	QR	S T U
1													
			ON 4.2.2 - EPA Rev 4						01.54		TA		TEST #2
3			RM (for one to four	pots)" it; unshaded cells ai					CLEA	R OLD DA	AIA		-
5	Qualitative data	S and arrow	vs are for user inpu	i, unsnaded cens at	nomalically displ	ay output	15		white: out	omatic out	ute		Measurements
6	Name(s) of Teste	r(c)	Faircloth, Williams	Ebersviller						user input	Juis		Time (in 24 hour form)
7	Test Number	(5)	2	, Ebersviller						PA addition			Weight of fuel
8	Date		2/8/2013							ention requ			Water temperature, Pot # 1
9	Location		Research Triangle	Park NC USA					,				Water temperature, Pot # 2
10	Stove type/model		Mwoto					User Name				Date	Water temperature, Pot # 3
11	Type of fuel (prima	arv)	red oak	Fuel Batch	2 Fuel Sample #	<b>#</b> 66	Data Entry		S. Ebersviller		25-	Jun-13	Water temperature, Pot # 4
12	Type of fuel (Add1			Fuel Batch			QA/QC Check						Weight of Pot # 1 with water
13	Fire-starting mate	rials (if any)	newspaper										Weight of Pot # 2 with water
14	Primary Fuel Data	3			units	label	Misc. Data			value	units	label	Weight of Pot # 3 with water
15	Fuel dimensions			See General Inform	nation sheet		Dry weight of F	ot#1(grams)		851.6	9	P1	Weight of Pot # 4 with water
16	Gross calorific val	ue (dry fuel)	19734	Measured Value	kJ/kg	HHV	Dry weight of P	ot#2 (grams)			9	P2	Weight of fire-starting mater
17	Net calorific value	(dry fuel)	18411	Calc'd from Msmt	kJ/kg	LHV	Dry weight of F	ot#3 (grams)			9	P3	Weight of charcoal+contain
18	Moisture content of	offuel	6.80	41323 jwf	%	m	Dry weight of F	ot#4 (grams)			9	P4	Weight of stove+charcoal
19	Fuel Carbon mas	s fraction	0.4959	Measured Value			Weight of emp	ty container for ch	ar		9	k	
20	Fuel Ash mass fra	action	0.0036	Measured Value	Get Fuel Inf	ormation				100.0	°C	To	Additional dry fuel (added w
21	Char Carbon mas	s fraction	0.9497	Measured Value			Mass of empty	stove before test		2761.2	9		Net
22	Char Ash mass fr		0.0096	Measured Value			Mass of empty	stove at end of te	st	2757.7	9		Moisture content of addition
23	Char calorific valu	e	33379	Measured Value	kJ/kg								Average
24													Type of Additional Dry fuel
25	Filter Information							Export .	All Filter Inform	nation			Pot on time
26	Filter ID	Туре	Phase	Duct			Import Gravimet	in Filme Date		Import E	2/00 D-1		Total mass of fuel
27	Number	(Q/T/Qb)	Sampled	(6/10)	Notes:		Import Gravimet	nc Filter Data		Import Ex	L/OC Data	3	Effective calorific value
	1384		CS	10									
29	1004	g											
29 30	1219	q t	CS	10									Calculations/Results
30 31		q t qb		10									Fuel consumed (moist)
30 31 32	1219 1385 1386	t	CS	10 10									Fuel consumed (moist)
30 31 32 33	1219 1385 1386 1220	t qb q t	CS CS hS hS	10 10 10									Fuel consumed (moist) Adjusted net change in char o Equivalent dry fuel consumed
30 31 32 33 34	1219 1385 1386 1220 1387	t qb	CS CS hs	10 10 10 10									Fuel consumed (moist) Adjusted net change in char of Equivalent dry fuel consumed Water vaporized from all pots
30 31 32 33 34 35	1219 1385 1386 1220 1387 1388	t qb q t	cs cs hs hs hs sim	10 10 10 10 10									Fuel consumed (moist) Adjusted net change in char of Equivalent dry fuel consumed Water vaporized from all pots Effective mass of water boiled
30 31 32 33 34 35 36	1219 1385 1386 1220 1387 1388 1221	t qb q t qb q t	cs cs hs hs sim sim	10 10 10 10 10 10 10									Fuel consumed (moist) Adjusted net change in char of Equivalent dry fuel consumed Water vaporized from all pots Effective mass of water boiled Time to boil Pot # 1
30 31 32 33 34 35 36 37	1219 1385 1386 1220 1387 1388	t qb q t qb	cs cs hs hs hs sim	10 10 10 10 10									Fuel consumed (moist) Adjusted net change in char of Equivalent dry fuel consumed Water vaporized from all pots Effective mass of water boiled Time to boil Pot# 1 Temp-corr time to boil Pot# 1
30 31 32 33 34 35 36 37 38	1219 1385 1386 1220 1387 1388 1221 1389	t qb q t qb q t qb	cs cs hs hs sim sim	10 10 10 10 10 10 10									Fuel consumed (moist) Adjusted net change in char d Equivalent dy fuel consumed Water vaporized from all pots Effective mass of water bolled Time to boil Pot# 1 Temp-corr time to boil Pot# 1 Thermal efficiency
30 31 32 33 34 35 36 37 38 39	1219 1385 1386 1220 1387 1388 1221 1389 Notes about this t	t qb q t qb q t qb	cs cs hs hs sim sim	10 10 10 10 10 10 10									Fuel consumed (moist) Adjusted net change in char d Equivalent dry fuel consumed Water vaporized from all pots Effective mass of water boiled Time to boil Pot # 1 Thermal efficiency Burning rate
10 11 12 13 14 15 16 17 18	1219 1385 1386 1220 1387 1388 1221 1389	t qb q t qb q t qb	cs cs hs hs sim sim	10 10 10 10 10 10 10									Fuel consumed (moist) Adjusted net change in char of Equivalent dy fuel consumed Water vaporized from all pots Effective mass of water boller Time to boil Pot# 1 Temp-corr time to boil Pot# 1 Thermal efficiency

-We've skipped the other two 'Results' tabs – very similar to CS-Result

-Also skipped 'General Info' tab – mostly same as the tab from the WBT spreadsheet on the Alliance website

-We HAVE moved some of the inputs to the Test tabs, because they vary from day-to-day

-This sheet (tab circled) will look very familiar to anyone who has used the WBT spreadsheet

A	В	С	D	E	F	G	H	1	J K	L	М	N C	9 P	QR	S T U
1 2 V	VATER BOILING TES	ST - VERSIO	N 4.2.2 - EPA Rev 4	4	++		+							_	TEST #2
3	DATA AND CALCU	LATION FO	RM (for one to four	pots)*							CLE	AR OLD DA	TA		
4				ut; unshaded cells a	utoma	atically dist	olav	outputs							
5	Qualitative data										white; ar	utomatic outp	outs		Measurements
6	Name(s) of Tester	(s)	Faircloth, Williams	, Ebersviller							gray	c user input			Time (in 24 hour form)
7	Test Number		2							$\rightarrow$	blue:	EPA addition	s		Weight of fuel
в	Date		2/8/2013							-	yellow: a	ttention requ	ired		Water temperature, Pot # 1
9	Location		Research Triangle	e Park, NC, USA											Water temperature, Pot # 2
0	Stove type/model		Mwoto							User Name			1	)ate	Water temperature, Pot # 3
1	Type of fuel (prima	ry)	red oak	Fuel Batch	2 F	uel Sample	#	66	Data Entry		S. Ebersviller		25-	Jun-13	Water temperature, Pot # 4
2	Type of fuel (Add1)	dry fuel)	*****	Fuel Batch	F	uel Sample	#		QA/QC Check						Weight of Pot # 1 with water
3	Fire-starting mater	ials (if any)	newspaper												Weight of Pot # 2 with water
4	Primary Fuel Data				u	nits		label	Misc. Data			value	units	label	Weight of Pot # 3 with water
15	Fuel dimensions			See General Inform	nation	sheet			Dry weight of P	ot#1(grams)		851.6	9	P1	Weight of Pot # 4 with water
6	Gross calorific valu	ue (dry fuel)	19734	Measured Value	k.	l/kg		HHV	Dry weight of P	ot#2 (grams)			9	P2	Weight of fire-starting mater
7	Net calorific value	(dry fuel)	18411	Calc'd from Msmt	l k	l/kg		LHV	Dry weight of P	ot # 3 (grams)			g	P3	Weight of charcoal+contain
8	Moisture content o	ffuel	6.80	41323 jwf	%			m	Dry weight of P	ot#4 (grams)			9	P4	Weight of stove+charcoal
9	Fuel Carbon mass	fraction	0.4959	Measured Value				1	Weight of empt	y container for ch	har		9	k	
10	Fuel Ash mass fra	ction	0.0036	Measured Value	1	Get Fuel Ir	nforn	nation	Local boiling p	pint		100.0	°C	To	Additional dry fuel (added w
1	Char Carbon mas	s fraction	0.9497	Measured Value	1				Mass of empty	stove before tes		2761.2	9		Net
2	Char Ash mass fra	action	0.0096	Measured Value	1				Mass of empty	stove at end of te	est	2757.7	9		Moisture content of addition:
3	Char calorific value	9	33379	Measured Value	ĸ	l/kg									Average
4					1										Type of Additional Dry fuel
15	Filter Information									Export	All Filter Infor	mation			Pot on time
6	Filter ID	Туре	Phase	Duct						Export	/ arr mor mor	indition			Total mass of fuel
7	Number	(Q/T/Qb)	Sampled	(6/10)		Notes:			Import Gravimetr	ic Filter Data		Import EC	C/OC Data	3	Effective calorific value
9	1384	q	CS	10											
0	1219	t	CS	10											Calculations/Results
11	1385	qb	CS	10											Fuel consumed (moist)
2	1386	q	hs	10	1										Adjusted net change in char d
13	1220	t	hs	10											Equivalent dry fuel consumed
4	1387	qb	hs	10											Water vaporized from all pots
5	1388	q	sim	10											Effective mass of water boiled
6	1221	t	sim	10											Time to boil Pot # 1
7	1389	qb	sim	10	1										Temp-corr time to boil Pot # 1
8					1										Thermal efficiency
9	Notes about this te	ist:													Burning rate
0	Fuel dimensions:														Specific fuel consumption
1	CS-2x2x3 175							1							Temp-corr so fuel consumption
•	H Summary	CS-Result	HS-Result	Simmer-Result / G	enera	l Informatio	n "	Test-	1 Test-2 Te	st-3 Test-4 🗸	Test-5 Tes	st-6 🔏 🖣 🔚			
	38							-	$\sim$						

-On this sheet:

-blue-shaded cells are EPA additions, features, or enhancements to the WBT spreadsheet

	A B	С	D	E	F G H	1	J K	L	M	N C	0 P (	QR	STU
1	WATER BOILING TEST	- VERSIC	N 4.2.2 - EPA Rev 4	1									TEST #2
	DATA AND CALCULA	TION FO	RM (for one to four	pots)*					CLE	AR OLD DA	ATA		
1	Gray-shaded cells a	and arrow	rs are for user inpu	it; unshaded cells a	utomatically displa	y output:	5						
5	Qualitative data							•	white: au	tomatic outp	outs		Measurements
6	Name(s) of Tester(s)	)	Faircloth, Williams	Ebersviller				$\rightarrow$	gray	user input			Time (in 24 hour form)
7	Test Number		2						blue: E	PA addition	s		Weight of fuel
8	Date		2/8/2013						yellow: at	tention requ	ired		Water temperature, Pot # 1
9	Location		Research Triangle	Park, NC, USA									Water temperature, Pot # 2
10	Stove type/model		Mwoto					User Name			D	ate	Water temperature, Pot # 3
1	Type of fuel (primary)	)	red oak	Fuel Batch	2 Fuel Sample #	66	Data Entry	S	Ebersviller		25-J	lun-13	Water temperature, Pot # 4
2	Type of fuel (Add'l dry	(fuel)		Fuel Batch	Fuel Sample #		QA/QC Check						Weight of Pot # 1 with water
13	Fire-starting material	ls (if any)	newspaper										Weight of Pot # 2 with water
4	Primary Fuel Data				units	label	Misc. Data			value	units	label	Weight of Pot # 3 with water
5	Fuel dimensions			See General Inform	nation sheet		Dry weight of F	ot#1 (grams)		851.6	9	P1	Weight of Pot # 4 with water
6	Gross calorific value	(dry fuel)	19734	Measured Value	kJ/kg	HHV	Dry weight of F	ot#2 (grams)			9	P2	Weight of fire-starting mater
7	Net calorific value (dr	ry fuel)	18411	Calc'd from Msmt	kJ/kg	LHV	Dry weight of F	ot # 3 (grams)			9	P3	Weight of charcoal+containe
18	Moisture content of fu	lei	6.80	41323 jwf	%	m	Dry weight of F	ot#4 (grams)			9	P4	Weight of stove+charcoal
19	Fuel Carbon mass fr	action	0.4959	Measured Value			Weight of emp	ty container for cha	r		9	k	
20	Fuel Ash mass fracti	on	0.0036	Measured Value	Get Fuel Info	rmation	Local boiling p	oint		100.0	°C	To	Additional dry fuel (added w
21	Char Carbon mass f	raction	0.9497	Measured Value			Mass of empty	stove before test		2761.2	9		Net
22	Char Ash mass fract	ion	0.0096	Measured Value			Mass of empty	stove at end of tes	t	2757.7	9		Moisture content of addition:
23	Char calorific value		33379	Measured Value	kJ/kg								Average
24													Type of Additional Dry fuel
15	Filter Information							Export A	JI Filter Inform	mation			Pot on time
26	Filter ID	Type	Phase	Duct					1				Total mass of fuel
7	Number (	Q/T/Qb)	Sampled	(6/10)	Notes:		Import Gravimet	ric Filter Data		Import E0	C/OC Data		Effective calorific value
9	1384	q	cs	10									
0	1219	t	CS	10									Calculations/Results
1	1385	qb	CS	10									Fuel consumed (moist)
	1386	q	hs	10									Adjusted net change in char de
2			hs	10									Equivalent dry fuel consumed
	1220	t											Water vaporized from all pots
3	1220 1387		hs	10									
3 4		qb	hs sim	10									Effective mass of water boiled
3 4 5	1387 1388		sim	10									
13 14 15 16	1387 1388 1221	qb q t	sim sim	10 10									Time to boil Pot # 1
12 13 14 15 16 17	1387 1388	qb	sim	10									Temp-corr time to boil Pot # 1
3 4 5 6 7 8	1387 1388 1221	qb q t qb	sim sim	10 10									Time to boil Pot # 1 Temp-corr time to boil Pot # 1 Thermal efficiency
3 4 5 6 7	1387 1388 1221 1389	qb q t qb	sim sim	10 10						1			Time to boil Pot # 1 Temp-corr time to boil Pot # 1

-On this sheet:

-Gray cells require user inputs, light gray are only used occasionally

В	С	D	E	F	G	H	1	J K	L	M	N (	D P	Q R	ST U
														TEST #2
										CLE	AR OLD DA	TA		
	s and arrow	vs are for user inpu	t; unshaded cells a	utomati	ically dis	play	output	5				_		
									$\rightarrow$			outs		Measurements
	(s)		Ebersviller											Time (in 24 hour form)
									_					Weight of fuel
										yellow: a	ttention requ	ired		Water temperature, Pot # 1
			Park, NC, USA	_										Water temperature, Pot # 2
									User Name					Water temperature, Pot # 3
		red oak					66			S. Ebersviller		25-	Jun-13	Water temperature, Pot # 4
			Fuel Batch	Fue	el Sample	e #		QA/QC Check						Weight of Pot # 1 with water
Fire-starting mater	rials (if any)	newspaper												Weight of Pot # 2 with water
							label					units		Weight of Pot # 3 with water
				nation s	sheet			Dry weight of P	ot#1(grams)		851.6	9		Weight of Pot # 4 with water
			Measured Value				HHV					9		Weight of fire-starting materi
		18411	Calc'd from Msmt		kg		LHV	Dry weight of P	ot#3 (grams)			9	P3	Weight of charcoal+containe
			41323 jwf	%			m					9		Weight of stove+charcoal
		0.4959	Measured Value							har		9		
				G	et Fuel I	Inforr	nation				100.0	-	To	Additional dry fuel (added w
Char Carbon mas	s fraction	0.9497	Measured Value					Mass of empty	stove before tes	2	2761.2	9		Net
			Measured Value					Mass of empty	stove at end of t	est	2757.7	9		Moisture content of addition:
Char calorific value	e	33379	Measured Value	kJ/ł	kg									Average
														Type of Additional Dry fuel
									Export	All Filter Infor	mation			Pot on time
										-			1	Total mass of fuel
Number	(Q/T/Qb)	Sampled	(6/10)		Notes:			Import Gravimeti	ic Filter Data		Import E	C/OC Dat	а	Effective calorific value
1384	q	CS	10											
	t	CS												Calculations/Results
1385	qb	CS	10											Fuel consumed (moist)
1386	q	hs	10											Adjusted net change in char d
1220	t	hs	10											Equivalent dry fuel consumed
1387	qb	hs	10											Water vaporized from all pots
1388	q	sim	10											Effective mass of water boiled
1221	t	sim	10											Time to boil Pot # 1
1389	qb	sim	10											Temp-corr time to boil Pot # 1
														Thermal efficiency
Notes about this te	est													Burning rate
Fuel dimensions:														Specific fuel consumption
							1							Temp-corr so fuel consumptio
	CS-Result	/ HS-Result / S	immer-Result 📈 G	ieneral I	Informati	on	Test-	1 Test-2 Te	st-3 Test-4	Test-5 Tes	t-6			
40							_	$\sim$						
40														
40														
	VATER BOILING TE: DATA AND CALCU Gray-shaded cell Qualitative data Tash Nameis / Grase Tash Names Date Location Tash Namber Date Location Stow typelmodel Type of tell (Adh Frie-staning mate Pried funding the Frie-staning mate Pried Staning mate Pried Catolom San Kota Santon Santon Stell Catolom Santon Stell Catolom Santon Char Ash mass fis Char Catolom Santon Stell Catolom Santon Char Catolom Santon Stell Catolom Santon Char Catolom Santon	VATER BOILING TEST - VERSIC DATA AND CALCULATION FO Gray-shaded cells and arroy Qualitative data Name(s) of Tester(s) Test Number Date Location Stove typelmodel Type of tuel (doth of tuel) Fire-starting materials (if any) Fuel dimensions Gross calorific value (dry huel) Moisture content of tuel Fuel Carbon mass fraction Char Ash mass fraction Char Ash mass fraction Char Cathon Char Cathon mass fraction Char Cathon mass fraction Ch	VATER BOILING TEST VERSION 4.2.2 - EPA Rev 4 VATER BOILING TEST VERSION 4.2.2 - EPA Rev 4 VATER BOILING TEST VERSION 4.2.2 - EPA Rev 4 VATER BOILING TEST VERSION 4.2.2 - EPA Rev 4 VATER BOILING TEST VERSION 4.2.2 - EPA Rev 4 VATER BOILING TEST VERSION 4.2.2 - EPA Rev 4 VATER BOILING TEST VERSION 2 VATER VERSION 2 VAT	VATER BOILING TEST - VERSION 4.2.2 - EPA Rev 4 VATER BOILING TEST - VERSION 4.2.2 - EPA Rev 4 VATER BOILING TEST - VERSION 4.2.2 - EPA Rev 4 VATER BOILING TEST - VERSION 4.2.2 - EPA Rev 4 VATER BOILING TEST - VERSION 4.2.2 - EPA Rev 4 VATER BOILING TEST - VERSION 4.2.2 - EPA Rev 4 VATER BOILING TEST - VERSION 4.2.2 - EPA Rev 4 VATER BOILING TEST - VERSION 4.2.2 - EPA Rev 4 VATER BOILING TEST - VERSION 4.2.2 - EPA Rev 4 VATER BOILING TEST - VERSION 4.2.2 - EPA Rev 4 VATER BOILING TEST - VERSION 4.2.2 - EPA Rev 4 VATER - VALUE - VERSION 4.2.2 - EPA Rev 4 VALUE - VERSION 4.2.2 - V	VATER BOILING TEST - VERSION 4.2.2 - EPA Rev 4 DATA AND CALCULATION FORM (for one to four pots)* Gray-shaded cells and arrows are for user input; unshaded cells automat Qualitative data Tast Number 2 Date 298.0013 Location Research Triangle Park, NC, USA Stove tpelmodel Mivelo Tipe of tuel (drift of tuel) Free-standing materials (framework) Free-standi	VATER BOILING TE ST - VERSION 4.2.2 - EPA Rev 4 VATER BOILING TE ST - VERSION 4.2.2 - EPA Rev 4 VATER BOILING TE ST - VERSION 4.2.2 - EPA Rev 4 VATER BOILING TE ST - VERSION 4.2.2 - EPA Rev 4 VATER BOILING TE ST - VERSION 4.2.2 - EPA Rev 4 VATER BOILING TE ST - VERSION 4.2.2 - EPA Rev 4 VATER BOILING TE ST - VERSION 4.2.2 - EPA Rev 4 VATER BOILING TE ST - VERSION 4.2.2 - EPA Rev 4 VATER BOILING TE ST - VERSION 4.2.2 - EPA Rev 4 VATER BOILING TE ST - VERSION 4.2.2 - EPA Rev 4 VATER BOILING TE ST - VERSION 4.2.2 - EPA Rev 4 VATER BOILING TE ST - VERSION - VERSIO	VATER BOILING TEST - VERSION 4.2.2 - EPA Rev 4 DATA AND CALCULATION FORM (for one to four pots)* Gray-shaded cells and arrows are for user input, unshaded cells automatically display Qualitative data Tash Names 2 Date 2080013 Location Research Triangle Park, NC, USA Stovi typelmodel Mwolo Type of tel/(doff of tel) File-standing materials (f any) Revegaper File-sta	VATER BOLLING TEST - VERSION 4.2.2 - EPA Rev 4 DATA AND CALCULATION FORM (for one to four pots)* Gray-shaded cells and arrows are for user input; unshaded cells automatically display output; Carautatave data Name(s) of Tester(s) Pairodon, Williams, Ebersviller Catalatave data Location Research Triangle Park, NC, USA Stove typelmodel Mivedo Tpe of thei (drif dry bel) Free-staning materials (f any) Revespaper Primary fuel data Fuel dimensions Cross calonfic value (dry help) Fuel Stand (arg) Revespaper F	VATER BOILING TEST - VERSION 4.2.2 - EPA Rev 4 DATA AUD CALCULATION FORM (for one to four pots)* Gray-shaded cells and arrows are for user input; unshaded cells automatically display outputs Qualitative data Name(s) of Tester(s). Fairdoffn, Williams, Ebersviller Test Number 2 Date 29/80013 Location Research Triangle Park, NJ, USA Stovi typelmodel Miwdo Type of tuel (drift y fuel) Fire-staning materials (far) inexpaper Primary Fuel data Fuel Batch Teuel Sample # Fire-staning materials (far) inexpaper Primary fuel data Fuel Contom assistation 0.0039 Heasured Value Fuel Carbon mass faction 0.4999 Heal Carbon mass faction 0.4999 Heal Carbon mass faction 0.4999 Heasured Value Char Ach mass faction 0.0039 Heasured Value Fire information Fire faction 0.0039 Heasured Value Fire faction factor 0.0039 Heasured Value Char Ach mass faction 0.0039 Heasured Value Fire information 1386 q. cs 10 1386 q. cs 10 1386 q. hs 10 1387 y b hs 10 1388 q. cs 3175 Heasured Value Fuel data mass factor 0.499 Heasured Value Fire information Fire factor mass factor 0.499 Heasured Value Fire factor factor 0.55 Fire 0.55 Fire factor 0.55 Fire factor 0	VATER BOLLNIG TE ST - VERSION 4.2.2 - EPA Rev 4 DATA AND CALCULATION FORM (for one to four pots)* Gray-shaded cells and arrows are for user input; unshaded cells automatically display outputs Qualitative data Name(s) of Tester(s). East Number 2 Date 23/02013 Location Research Triangle Park, NC, USA Stove typelmodel Mixedo Type of tuel (ddf vg tue) Free-staning materials (f any) Revispager Primary Jurg Data Free-staning materials (f any) Revispager Primary Jurg Data Staning Materials (f any) Revispager Primary Jurg Data Data Staning Staning Data Jurg Revispager Primary Jurg Data Jurg Revispager Data Staning Data Jurg Revispager Primary Jurg Data Jurg Revispager Data Staning Data Jurg Revispager Jurg Revispager Data Staning Data Jurg Revispager Jurg Revispager Data Staning Data Jurg Revispager Jurg	VATER BOILING TEST - VERSION 4.2.2 - EPA Rev 4 DATA Alto CALCULATION FORM for one to four pots? Gray-abaded cells and arrows are for user input; unshaded cells automatically display outputs Qualitative data Name(s) OT Ester(s). Test Number 2 Date 2082013 Location Research Triangle Park, NC, USA Stove typelmodel Neved Prev Etanding materials (dary held) Frev Etang materials (dary held) Frev Etang materials (dary newspaper Primary Fuel Data Frev Etang materials (dary newspaper Primary Fuel Data Fuel Gardon mass faction Char Cathor mass faction Char Cathor mass faction Char Cathor mass faction Char Abin mass faction Char Cathor mass faction Char Cathor mass faction Char Cathor mass faction Char Abin mass faction Char Cathor mass faction Char Cathor mass faction Char Abin mass faction Char Abin mass faction Char Cathor mass faction Char Abin mass faction	VATER BOILING TEST - VERSION 4.2.2 - EPA Rev 4 DATA Alto CALCULATION FORM for one to four pots? Gray-abaded cells and arrows are for user input; unshaded cells automatically display outputs Qualitative data Target statumer 2 Date 2/82013 Location Research Triangle Park, NC, USA Stove typelmodel Alwool Type of tel (4014 y fuel) Free-taining materials (401 y fuel) Free-	VATER BOILING TEST - VERSION 4.2.2 - EPA Rev 4 VATER BOILING TEST - VERSION 4.2.2 - EPA Rev 4 Grav-badded cells and arrows are for user input, unshaded cells automatically display ourgurs Grav-badded cells and arrows are for user input, unshaded cells automatically display ourgurs Qualitative data Targe user input, unshaded cells automatically display ourgurs Qualitative data Price faming materials (f any hewspaper Price faming materia	VALER BOLING TEST - VERSION 4.2.2 - EPA Rev 4 DATA AND CALCULATION FORM for one to four pots)* Gray-abaded cells and arrows are for user input; unshaded cells automatically display outputs Qualitative data Target user input; unshaded cells automatically display outputs Date 2/82013 Location Presenth Triangle Park, NC, USA Stove typelmodel Meetig formary) Type of thei (Add for beta) Free-stating materials (far) here Primary fuel (grimary) Type of thei (Add for beta) Free-stating materials (far) here Primary fuel (grimary) Free-stating materials (far) here Primary fuel (grimary) Free-stating materials (far) here Free-stating materials (far) here Free-stat

-On this sheet:

-White cells are filled automatically by either an active formula or automated code

A	В	С	D	E	F	G	Н	1	J K	L	M	N (	) P	QR	S T U
2 V	VATER BOILING TE	ST - VERSIO	ON 4.2.2 - EPA Rev 4	4	-		-			_				_	TEST #2
3	DATA AND CALCU	JLATION FO	RM (for one to four	pots)*							CLE	AR OLD DA	TA		
1				ut; unshaded cells a	utoma	tically dis	olay	outputs	;						
5	Qualitative data										white: au	tomatic out	outs		Measurements
5	Name(s) of Teste	r(s)	Faircloth, Williams	s, Ebersviller							gray	: user input			Time (in 24 hour form)
7	Test Number		2								blue: E	EPA addition	s		Weight of fuel
3	Date		2/8/2013								yellow; al	ttention requ	ired		Water temperature, Pot # 1
9	Location		Research Triangle	e Park, NC, USA											Water temperature, Pot # 2
0	Stove type/model		Mwoto							User Name			1	)ate	Water temperature, Pot # 3
1	Type of fuel (prima	ary)	red oak	Fuel Batch	2 Fu	el Sample	#	66	Data Entry		S. Ebersviller		25-	Jun-13	Water temperature, Pot # 4
2	Type of fuel (Add1	dry fuel)		Fuel Batch	Fu	el Sample	#		QA/QC Check						Weight of Pot # 1 with water
3	Fire-starting mate	rials (if any)	newspaper												Weight of Pot # 2 with water
4	Primary Fuel Data	3			ur	iits		label	Misc. Data			value	units	label	Weight of Pot # 3 with water
5	Fuel dimensions			See General Inform	nation	sheet			Dry weight of P	ot#1(grams)		851.6	9	P1	Weight of Pot # 4 with water
6	Gross calorific val	ue (dry fuel)	19734	Measured Value	kJ	/kg		HHV	Dry weight of P	ot#2 (grams)			9	P2	Weight of fire-starting mate
7	Net calorific value	(dry fuel)	18411	Calc'd from Msmt	kJ	/kg		LHV	Dry weight of P	ot # 3 (grams)			g	P3	Weight of charcoal+contain
8	Moisture content of	offuel	6.80	41323 jwf	%			m	Dry weight of P	ot#4 (grams)			9	P4	Weight of stove+charcoal
9	Fuel Carbon mas	s fraction	0.4959	Measured Value				1	Weight of empl	y container for c	har		9	k	
0	Fuel Ash mass fra	action	0.0036	Measured Value		Get Fuel I	nforn	nation	Local boiling p	pint		100.0	°C	To	Additional dry fuel (added w
1	Char Carbon mas	s fraction	0.9497	Measured Value	1				Mass of empty	stove before tes	1	2761.2	9		Net
2	Char Ash mass fr	action	0.0096	Measured Value	1				Mass of empty	stove at end of t	est	2757.7	9		Moisture content of addition
3	Char calorific valu	е	33379	Measured Value	l kj	/kg									Average
4					1										Type of Additional Dry fuel
5	Filter Information									Export	All Filter Infor	mation			Pot on time
6	Filter ID	Type	Phase	Duct						E Apor		indition			Total mass of fuel
7	Number	(Q/T/Qb)	Sampled	(6/10)		Notes:			Import Gravimet	ic Filter Data		Import E	C/OC Data	•	Effective calorific value
9	1384	q	CS	10											
0	1219	t	CS	10											Calculations/Results
1	1385	qb	CS	10											Fuel consumed (moist)
2	1386	q	hs	10											Adjusted net change in char of
3	1220	t	hs	10											Equivalent dry fuel consumed
4	1387	qb	hs	10											Water vaporized from all pots
5	1388	q	sim	10											Effective mass of water boiled
6	1221	t	sim	10											Time to boil Pot # 1
7	1389	qb	sim	10											Temp-corr time to boil Pot # 1
8															Thermal efficiency
9	Notes about this t	est													Burning rate
0	Fuel dimensions:														Specific fuel consumption
1	CS-2x2x3 175							1							Temp-corr so fuel consumpti
•	H Summary	CS-Result	HS-Result	Simmer-Result / G	eneral	Informatio	n "	Test-	1 Test-2 Te	st-3 Test-4	Test-5 Tes	t-6			
	41														

-Other enhancements on this sheet include:

-fuel elemental analysis, moisture content, and calorific values are entered automatically when button is clicked

A	В	С	D	E	F G	H	1 1	J K	L	M	N (	0 P	QR	S T U
L	VATER BOILING TES		100 501 0			-	-							TEST #2
										015		TA		IEST#2
	DATA AND CALCUL		KM (for one to four)							CLE	AR OLD DA	AIA		H
	Qualitative data	anu an os	vs are for user inpu	t, unsnaded cens a	utomatically	uispia	ау оифи	15		white: ar	utomatic out	ute		Measurements
	Name(s) of Tester(	=)	Faircloth, Williams,	Ebersviller							c user input	7010		Time (in 24 hour form)
	Test Number	"	2	Locionnei							EPA addition			Weight of fuel
	Date		2/8/2013								ttention requ			Water temperature, Pot # 1
	Location		Research Triangle	Park NC USA					-	,				Water temperature, Pot # 2
)	Stove type/model		Mwoto						User Name			1	Date	Water temperature, Pot # 3
	Type of fuel (primar	0	red oak	Fuel Batch	2 Fuel Sar	nole #	66	Data Entry		S. Ebersviller			Jun-13	Water temperature, Pot # 4
2	Type of fuel (Add'l d			Fuel Batch				QA/QC Check						Weight of Pot # 1 with wate
3	Fire-starting materia		newspaper											Weight of Pot # 2 with wate
	Primary Fuel Data				units	_	label	Misc. Data			value	units	label	Weight of Pot # 3 with wate
5	Fuel dimensions			See General Inform		-			ot # 1 (grams)		851.6	q	P1	Weight of Pot # 4 with wate
5	Gross calorific value	e (dry fuel)	19734	Measured Value	kJ/kg		HHV	Dry weight of F				9	P2	Weight of fire-starting mate
7	Net calorific value (		18411	Calc'd from Msmt	kJ/kg		LHV	Dry weight of F				9	P3	Weight of charcoal+contain
3	Moisture content of		6.80	41323 jwf	%		m		Pot#4 (grams)			9	P4	Weight of stove+charcoal
)	Fuel Carbon mass	fraction	0.4959	Measured Value					ty container for c	har		Q	k	
)	Fuel Ash mass frac	tion	0.0036	Measured Value	Get Fu	uel Infi	ormation	Local boiling p	oint		100.0	°C	Tb	Additional dry fuel (added y
1	Char Carbon mass	fraction	0.9497	Measured Value	1			Mass of empty	stove before tes	1	2761.2	9		Net
2	Char Ash mass fra	tion	0.0096	Measured Value				Mass of empty	stove at end of t	est	2757.7	9		Moisture content of addition
3	Char calorific value		33379	Measured Value	kJ/kg									Average
1														Type of Additional Dry fuel
5	Filter Information								Export	All Filter Infor	mation			Pot on time
5	Filter ID	Туре	Phase	Duct						I I				Total mass of fuel
7	Number	(Q/T/Qb)	Sampled	(6/10)	Notes	0		Import Gravimet	ric Filter Data		Import E	C/OC Data	э 🛛	Effective calorific value
	1384	q	cs	10										
5	1219		cs	10						••••••				Calculations/Results
1	1385	qb	cs	10	1									Fuel consumed (moist)
2	1386	q	hs	10										Adjusted net change in char
3	1220	t	hs	10										Equivalent dry fuel consumer
	1387	qb	hs	10										Water vaporized from all pots
	1388	q	sim	10	1									Effective mass of water boile
	1221	t	sim	10										Time to boil Pot # 1
	1389	qb	sim	10										Temp-corr time to boil Pot #
3					1									Thermal efficiency
9	Notes about this te	st			_	-	_				_	_		Burning rate
)	Fuel dimensions:													Specific fuel consumption
	CS-2x2x3175 m	n					1							Temp-corr sp fuel consumpt
•	H Summary /	CS-Result	📝 HS-Result 📈 S	immer-Result 📈 G	eneral Inform	nation	Test	-1 Test-2 T	est-3 / Test-4	Test-5 Tes	st-6 🛛 🖣 🔚	ш		
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-Other enhancements on this sheet include:

-PM filter identification block w/ filter ID number and parameters specific to our laboratory

-Helps us connect specific filters with specific tests

1	U	V	W	Х	Y	Z	AB	AC	AD	AE A	AG	AH	AJ	AK
2	TEST #2		со	LD START H	IGH POWER		HOT ST	ART HIG	3H POWER (OPT	IONAL)		SIM	MER TEST	
3 4	Insert Data		Start		Finish: w Pot#1 b		Start			h: when #1 boils	Start		Finish: ~30	min
4 5	Measurements	Units	data	label	data	label	data	label	data	label	data	label	data	lab
5	Time (in 24 hour form)	h:min:s	12:45:45	t <sub>a</sub>	13:12:45	t.	13:24:00	t.	13:48:00	ter .	13:50:33	tel	14:21:00	ter
7	Weight of fuel	9	530.7	t,	0	t.	1159.1		474.2	f.	434.4	t,	0	fe
8	Water temperature, Pot # 1	°C	19.8	T1 <sub>cl</sub>	93.0	T1 <sub>et</sub>	22.5		99.8	T1 <sub>M</sub>	97.7	T1 <sub>al</sub>	94.3	T1,
9	Water temperature, Pot # 2	°C		T2 <sub>cl</sub>		T2 <sub>ef</sub>		T2 <sub>N</sub>		T2 <sub>M</sub>		T2 <sub>8</sub>		T2
10	Water temperature, Pot # 3	*C		T3 <sub>cl</sub>		T3 <sub>ef</sub>		T3 <sub>nl</sub>		T3 <sub>rf</sub>		T3 <sub>El</sub>		T3
11	Water temperature, Pot # 4	°C		T4 <sub>ct</sub>		T4 <sub>ct</sub>		T4 <sub>nt</sub>		T4.		T4 <sub>st</sub>		Τ4,
12	Weight of Pot # 1 with water	9	5850.9	P1 <sub>a</sub>	5704.4	P1 <sub>et</sub>	5851.7	P1 <sub>n</sub>	5635.8	P1 <sub>m</sub>	5611.1	P1 <sub>El</sub>	4899.1	P1
13	Weight of Pot # 2 with water	9		P2 <sub>d</sub>		P2 <sub>ef</sub>		P2 <sub>n</sub>		P2 <sub>M</sub>		P2 <sub>8</sub>		P2
14	Weight of Pot # 3 with water	9		P3 <sub>d</sub>		P3 <sub>ef</sub>		P3 <sub>N</sub>		P34		P3 <sub>st</sub>		P3,
15	Weight of Pot # 4 with water	9		P4 <sub>cl</sub>		P4 <sub>ef</sub>		P4 <sub>n</sub>		P4m		P4 <sub>st</sub>		P4
16	Weight of fire-starting materials (if any)	9	10				10.4							
17	Weight of charcoal+container	9										1		
18	Weight of stove+charcoal	9	2761.2		2826.3		2757.7		2854.3		2859.9	1	2927.1	
19	Net mass of charcoal				65.1	ΔC <sub>0</sub>			96.6	ΔC <sub>h</sub>		ſ	67.2	∆C <sub>s</sub>
20	Additional dry fuel (added w/ wet fuel)	9		faco.cl		factor		facting		factor		facture		facts
21	Net mass of additonal fuel	9			0	∆f <sub>act.c</sub>			0	∆f <sub>add,h</sub>			0	∆f <sub>acc</sub>
22	Moisture content of additional dry fuel	96		macolo				m <sub>atth</sub>				matta		
23	Average fuel moisture content	%			6.80	mago			6.80	magn			6.80	marg
24	Type of Additional Dry fuel				Is char discar	ded								
25	Pot on time	h:min:s	12:47:04	top	after Cold Sta		13:25:15	t <sub>ep</sub>						
26	Total mass of fuel	0	530.7	fom	yes	(yes/no)	684.9			1	434.4	fam		
27	Effective calorific value	kJ/kg	16,984	Cerr			16,984	Cet			16984	Cet		
28														
29			COLD START		HOT START					IMMER TEST (CAL	CULATIONS			
30	Calculations/Results	Units	data	label	data	label	Calculation					Units	<u>data</u>	labe
31	Fuel consumed (moist)	9	530.7	fom	684.9	fnn				ier phase (moist)		9	434.4	fam
32	Adjusted net change in char during test	g	63.9	∆c <sub>o</sub> '	95.2	∆c <sub>n</sub> '			ge in char duri	ng test		g	64.1	∆cs
33	Equivalent dry fuel consumed	9	373.7	f <sub>oo</sub>	459.2	fna	Equivalent		consumed			9	284.6	f <sub>ac</sub>
34	Water vaporized from all pots	9	146.5	Wov	215.9	Why	Water vapo					g	712.0	Wav
35	Effective mass of water boiled	9	4427.4	Wor	4771.9	Whr			t end of simm	er - All Pots		g	4047.5	War
36	Time to boil Pot # 1	min	27.00	∆t₀	24.00	Δt <sub>n</sub>	Time of sin					min	30.45	∆ts
	Temp-corr time to boil Pot # 1	min	27.68	∆t <sup>⊤</sup> c	23.29	∆t <sup>⊤</sup> n	Thermal eff					96	29.5%	h <sub>s</sub>
37	Thermal efficiency	%	27.1%	ho	24.9%	ha	Burning rat					g/min	9.3	r <sub>ab</sub>
37 38		g/min	13.8	r <sub>ob</sub>	19.1	r <sub>no</sub>	Specific fue	el consu	Imption			g/liter	70.3	SC
37 38 39	Burning rate				96.2		Firepower					watts	2868	FP,
37 38	Burning rate Specific fuel consumption	g/liter	84.4 General Inform	SC.	est-1 Test-2		/Test-4 /Tes					mana		

- Same sheet scrolled to the right (tab circled)
- This area of the sheet is also (mostly) consistent with WBT spreadsheet
- Added (blue-shaded areas)...

	U	V	W	Х	Y	Z	AB	AC	AD	AE 4	AG	AH	AJ	AK
2	TEST #2		cc	LD START HK	GH POWER		HOT ST	ART HK	SH POWER (OP	TIONAL)		SIM	MER TEST	
	Insert Data		Star	1	Finish: w		Start			h: when	Start		Finish: ~30	min
		Units	4.4	label	Pot#1b		4.4	label		#1 boils		1-1-1	4.4.	1-1-1
	Measurements Time (in 24 hour form)	h:min:s	data 12:45:45	t <sub>el</sub>	data 13:12:45	label t <sub>er</sub>	data 13:24:00		data 13:48:00	label ter	data 13:50:33	label t <sub>el</sub>	data 14:21:00	labi t <sub>er</sub>
	Weight of fuel	n.min.s	12.40.40	tei fei	13.12.45	te fe	13.24.00		474.2	ter fer	434.4	fa	14.21.00	fer
	Water temperature, Pot # 1	9 *C	19.8	T1 <sub>a</sub>	93.0	T1 <sub>a</sub>	22.5		99.8	T1w	434.4	T1 <sub>al</sub>	94.3	T1
	Water temperature, Pot # 2	°C	10.0	T2 <sub>cl</sub>	33.0	T2 <sub>ef</sub>	22.0	T2 <sub>N</sub>	00.0	T2 <sub>M</sub>	01.1	T2 <sub>st</sub>	64.5	T2
)	Water temperature, Pot # 3	*C		T3n		T3.		T3 <sub>n</sub>		T3.		T3 <sub>st</sub>		T3,
	Water temperature. Pot # 4	*C		T4 <sub>cl</sub>		T4 <sub>ef</sub>		T4 <sub>n</sub>		T4w		T4 <sub>st</sub>		T4,
2	Weight of Pot # 1 with water	a	5850.9	P1 <sub>d</sub>	5704.4	P1 <sub>et</sub>	5851.7		5635.8	P1e	5611.1	P1 <sub>st</sub>	4899.1	P1
3	Weight of Pot # 2 with water	0		P2 <sub>cl</sub>		P2 <sub>ef</sub>		P2 <sub>N</sub>		P2 <sub>M</sub>		P2.		P2
	Weight of Pot # 3 with water	9		P3 <sub>el</sub>		P3er		P3.		P3.4		P3 <sub>st</sub>		P3,
5	Weight of Pot # 4 with water	9		P4 <sub>pl</sub>		P4 <sub>et</sub>		P4 <sub>n</sub>		P4m		P4 <sub>st</sub>		P4
6	Weight of fire-starting materials (if any)	9	10			-	10.4							
7	Weight of charcoal+container	9										- 1		
3	Weight of stove+charcoal	a	2761.2		2826.3		2757.7		2854.3		2859.9		2927.1	
9	Net mass of charcoal				65.1	ΔC <sub>0</sub>			96.6	ΔC <sub>2</sub>		- r	67.2	۵C
0	Additional dry fuel (added w/ wet fuel)	9		factor		factor		facting		facent		factor		facto
1	Net mass of additonal fuel				0	Δfact.c			0	∆f <sub>act</sub> n			0	Δface
2	Moisture content of additional dry fuel	96		mass				matth				matta		
3	Average fuel moisture content	%		- (	6.80	mage			6.80	magh			6.80	marg
1	Type of Additional Dry fuel				Is char discar									
5	Pot on time	h:min:s	12:47:04	top	after Cold Sta	rt?	13:25:15	top						
6	Total mass of fuel	g	530.7	fom	yes	(yes/no)	684.9	fam			434.4	fam		
	Effective calorific value	kJ/kg	16,984	Cer			16,984	Cer			16984	Cer		
3														
9			COLD START		HOT START			_		IMMER TEST (CAL	CULATIONS			
	Calculations/Results Fuel consumed (moist)	Units	data 530.7	label	data 684.9	label	Calculation			ner phase (moist)		Units	<u>data</u> 434.4	labe
2	Adjusted net change in char during test	9	63.9	fom	95.2	fnm			oning the simin ge in char duri			9	64.1	fam
	Equivalent dry fuel consumed	9	373.7	∆c <sub>o</sub> ' f <sub>oo</sub>	459.2	∆c <sub>n</sub> ' f <sub>re</sub>	Equivalent			ng test		9	284.6	∆cs' feo
	Water vaporized from all pots	g	146.5	T <sub>00</sub> Way	215.9	Ng Way	Water vapo		consumed			9 0	712.0	
	Effective mass of water boiled	g	4427.4	Wov	4771.9	W <sub>N</sub>			t end of simm	er - All Dote		g	4047.5	Wa
	Time to boil Pot # 1	g	27.00	w <sub>or</sub> ∆t₀	24.00	W <sub>hr</sub> Δt <sub>n</sub>	Time of sin		t end of simm	er - All Pots		min	30.45	W <sub>6</sub> ∆t <sub>s</sub>
	Temp-corr time to boil Pot # 1	min	27.68	$\Delta t_{c}^{T}$	24.00	∆t <sup>™</sup> n	Thermal ef					96	29.5%	h
7	Thermal efficiency	%	27.00	h <sub>n</sub>	23.29	h <sub>n</sub>	Burning rat					70 g/min	9.3	r <sub>sb</sub>
		a/min	13.8	fee	19.1	r <sub>np</sub>	Specific fue		motion			a/liter	70.3	SC
3	Burging rate		13.0	SC.	96.2	SCI	Firepower	i const	Inpuon			watts	2868	FP
3	Burning rate Specific fuel consumption	g/liter	84.4											

-Added (blue-shaded areas):

-Accounting for mixture of low-moisture and high-moisture fuel

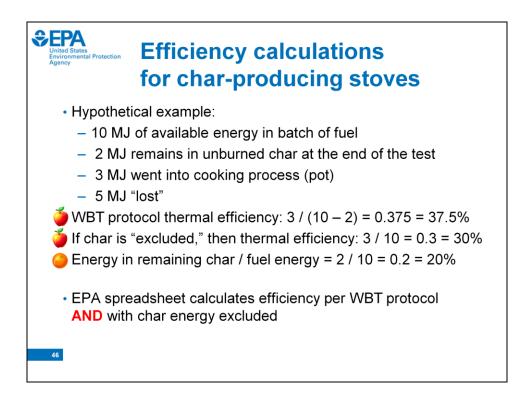
-Automatically filled by active formulas in worksheet

	U	V	W	Х	Y	Z	AB	AC	AD	AE .	A AG	AH	AJ	AK
	TEST #2		cc	LD START HI	GH POWER		HOT ST	ART HK	SH POWER (OPT	IONAL)		SIM	MER TEST	
	Insert Data		Star		Finish: w	/hen	Start		Finis	h: when	Start		Finish: ~30	min
	Insert Data				Pot#1 b	oils			Pot#	1 boils				
	Measurements	Units	data	label	data	label	data	label	data	label	data	label	data	labe
	Time (in 24 hour form)	h:min:s	12:45:45	ta	13:12:45	ter.	13:24:00		13:48:00	ter	13:50:33	t <sub>el</sub>	14:21:00	t <sub>er</sub>
7	Weight of fuel	9	530.7	fa	0	fe	1159.1		474.2	fer	434.4	fal	0	fer
	Water temperature, Pot # 1	°C	19.8	T1 <sub>cl</sub>	93.0	T1 <sub>ct</sub>	22.5		99.8	T1 <sub>M</sub>	97.7	T1 <sub>st</sub>	94.3	T1 <sub>at</sub>
1	Water temperature, Pot # 2	°C		T2 <sub>d</sub>		T2 <sub>d</sub>		T2 <sub>n</sub>		T2 <sub>M</sub>		T2 <sub>81</sub>		T2 <sub>ef</sub>
0	Water temperature, Pot # 3	°C		T3 <sub>cl</sub>		T3 <sub>cf</sub>		T3 <sub>ni</sub>		T3 <sub>rf</sub>		T3 <sub>si</sub>		T3 <sub>st</sub>
1	Water temperature, Pot # 4	°C		T4 <sub>cl</sub>		T4 <sub>cf</sub>		T4 <sub>ni</sub>		T4 <sub>nf</sub>		T4 <sub>si</sub>		T4 <sub>st</sub>
2	Weight of Pot # 1 with water	9	5850.9	P1 <sub>cl</sub>	5704.4	P1 <sub>et</sub>	5851.7		5635.8	P1 <sub>ef</sub>	5611.1	P1 <sub>si</sub>	4899.1	P1 <sub>ef</sub>
3	Weight of Pot # 2 with water	9		P2 <sub>d</sub>		P2 <sub>d</sub>		P2 <sub>N</sub>		P2 <sub>M</sub>		P2 <sub>sl</sub>		P2 <sub>st</sub>
4	Weight of Pot # 3 with water	9		P3 <sub>d</sub>		P3 <sub>ef</sub>		P3 <sub>N</sub>		P3 <sub>M</sub>		P3 <sub>sl</sub>		P3 <sub>ef</sub>
5	Weight of Pot # 4 with water	9		P4 <sub>cl</sub>		P4 <sub>et</sub>		P4 <sub>nl</sub>		P4 <sub>m</sub>		P4 <sub>sl</sub>		P4 <sub>st</sub>
6	Weight of fire-starting materials (if any)	9	10				10.4							
7	Weight of charcoal+container	9												
8	Weight of stove+charcoal	9	2761.2		2826.3		2757.7		2854.3		2859.9	- H	2927.1	
9	Net mass of charcoal	-			65.1	∆c <sub>o</sub>			96.6	Δch			67.2	∆C <sub>s</sub>
0	Additional dry fuel (added w/ wet fuel)	9		f <sub>add,cl</sub>		fact,cr		facc,nci		fact.m		facture	-	faco.st
1	Net mass of additonal fuel				0	∆f <sub>add,c</sub>			0	∆f <sub>add,h</sub>		-	0	∆f <sub>add,</sub>
2	Moisture content of additional dry fuel	%		m <sub>add,c</sub>	<u> </u>			m <sub>add,h</sub>				m <sub>atta</sub>		
3	Average fuel moisture content	%				m <sub>aig.c</sub>			6.80	m <sub>agh</sub>		F	6.80	maigi
4	Type of Additional Dry fuel				Is char discar									
5	Pot on time	h:min:s	12:47:04	<u> </u>	after Cold Sta		13:25:15							
6	Total mass of fuel	g kJ/kg	530.7 16.984	om	yes	(yes/no)	684.9 16,984				434.4	fam		
27 28	Effective calorific value	KJ/Kg	10,984	Cer			10,904	Cer			10984	Cer		
9			COLD START		HOT START				S	MMER TEST (CA	CULATIONS	DIFFER FF	ROM HIGH POWE	R TEST
80	Calculations/Results	Units	data	label	data	label	Calculation	ns/Resu	its			Units	data	labe
1	Fael consumed (moist)	y	530.7	om	084.9	inn i	Fuel consu	med da	ning the simm	er phase (moist	,	9	434.4	-an
32	Adjusted net change in char during test	g	63.9	∆c <sub>o</sub> "	95.2	∆c <sub>n</sub> '	Adjusted ne	et chan	ge in char duri	ng test		9	64.1	∆c <sub>s</sub> '
33	Equivalent dry fuel concurred	-	272.7	6	450.2		Equivalent	dey fuol	concurred			-	294.6	
84	Water vaporized from all pots	9	146.5	Wov	215.9	Wnv	Water vapo	rized				g	712.0	Way
5	Effective mass of water boiled	9	4427.4	Wor	4771.9	Wnr	Water rema	aining a	t end of simm	er - All Pots		9	4047.5	War
6	Time to boil Pot # 1	min	27.00	∆t₀	24.00	Δt <sub>n</sub>	Time of sim	nmer				min	30.45	∆t₀
7	Temp-corr time to boil Pot # 1	min	27.68	∆t <sup>T</sup> c	23.29	∆t <sup>⊤</sup> n	Thermal eff	ficiency				96	29.5%	h <sub>8</sub>
8	Thermal efficiency	%	27.1%	ho	24.9%	ha	Burning rat	е				g/min	9.3	r <sub>sb</sub>
	Burning rate	g/min	13.8	r <sub>co</sub>	19.1	r <sub>no</sub>	Specific fue	el consu	umption			g/liter	70.3	SC,
9	Specific fuel consumption	g/liter	84.4	SC.	96.2	SU	Firepower					watts	2868	FP <sub>6</sub>
9								st-5 /						

-Added (blue-shaded areas):

- Accounting for ash content of fuel and remaining char
  - Especially useful for charcoal stoves/stoves that aren't emptied between phases

-AND Char-producing stoves



Now let's discuss efficiency calculations for char-producing stoves. As I mentioned before, there has been debate on this topic, and our goal at EPA is to report efficiency in a way that is fair and is clear to all stakeholders. I think it is easiest to explain the calculations using this hypothetical example. Let's say we begin with a batch of fuel with 10 MJ of available energy. We find 2 MJ of energy remains in the unburned char at the end of the test, and 3 MJ went into the cooking process. 5 MJ of energy was "lost" to the surroundings. Let's look at the first apple on the slide – the efficiency calculation specified in the WBT protocol gives full credit for the energy in the remaining char – the 2 MJ of char energy is subtracted from the 10 MJ of total energy - there is an assumption that the energy in the char represents unused energy that can be used later. In this example, thermal efficiency is 37.5%. Now let's look at the second apple – efficiency can also be calculated with the char energy "excluded," and this would apply only if the char is discarded or is used for some purpose other than for fuel (such as for biochar). Now let's look at the orange on the slide – we can calculate the ratio of the energy in the remaining char to the total available fuel energy – in this case, it is 20%. You may want to maximize this number if an objective of your stove program is to produce char (whether it is for fuel, biochar, carbon credits, or other purposes). But if your stove program is in an area where people actually discard the char, then you may consider this number as a loss of potential energy from the fuel. On the other hand, if your fuel is some type of waste biomass (such as waste rice hulls) the loss may not matter anyway. Let's look at the two apples on the slide again – we CAN compare thermal efficiencies with and without the char energy credit. However, we cannot add the numbers for the second apple and the orange – we cannot say the stove in this example is 50% efficient because the thermal efficie

Now Seth will continue with the tour of the spreadsheet, picking up with the efficiency calculations for this example with the char-producing stove.

		COLD START		HOT START		SIMMER TEST (CALCULA	TIONS DIFFER FR	OM HIGH POWE	RTEST
Calculations/Results	Units	<u>data</u>	label	data	label	Calculations/Results	Units	data	labe
Fuel consumed (moist)	g	530.7	fom	731.7	fm	Fuel consumed during the simmer phase (moist)	g	384.8	fam
djusted net change in char during test	9	63.9	∆c₀'	142.3	∆c <sub>n</sub> '	Adjusted net change in char during test	9	14.0	∆c₊
Equivalent dry fuel consumed	g	373.7	foo	417.0	fed	Equivalent dry fuel consumed	g	329.6	f <sub>ed</sub>
Vater vaporized from all pots	9	146.5	Wov	215.9	Wnv	Water vaporized	9	712.0	Wav
ffective mass of water boiled	9	4427.4	Wor	4771.9	Wm	Water remaining at end of simmer - All Pots	9	4047.5	War
ime to boil Pot # 1	min	27.00	∆t₀	24.00	∆t <sub>n</sub>	Time of simmer	min	30.45	∆t₄
emp-corr time to boil Pot # 1	min	27.68	∆t <sup>⊤</sup> ₀	23.29	∆t <sup>7</sup> n	Thermal efficiency	%	25.5%	h <sub>a</sub>
'hermal efficiency	%	27.1%	ho	27.4%	h	Burning rate	g/min	10.8	r <sub>sb</sub>
Burning rate	g/min	13.8	r <sub>co</sub>	17.4	r <sub>ro</sub>	Specific fuel consumption	g/liter	81.4	SC,
Specific fuel consumption	g/liter	84.4	SCo	87.4	SC <sub>n</sub>	Firepower	watts	3322	FP.
emp-corr sp fuel consumption	g/liter	86.5	SC <sup>T</sup> o	84.8	SC <sup>T</sup>	Turn down ratio	-	1.28	TDR
emp-corr sp energy consumpt.	kJ/liter	1593	SETc	1561	SE <sup>T</sup> H	Specific Energy Consumption	kJ/liter	1499	SEs
emp-con splenergy consumpt.									BF
	watts	4247	FP <sub>o</sub>	5331	FP <sub>n</sub>	T-corrected Fuel Benchmark to Complete 5L WBT	g	835	BF
ire power Cooking power	watts watts	4247 1149	FP <sub>0</sub> CP <sub>0</sub>	402		Corrected Energy Benchmark to Complete 5L WBT	2 Li	835	BE
ire power Cooking power	watts watts	4247 1149	CPe	402	CP <sub>n</sub>	Corrected Energy Benchmark to Complete 5L WBT			
ire power Cooking power	watts watts	4247 1149	CPe	402	CP <sub>n</sub>	Corrected Energy Benchmark to Complete 5L WBT			
ire power Cooking power	watts watts	4247 1149	CPe	402	CP <sub>n</sub>	Corrected Energy Benchmark to Complete 5L WBT			
ire power Cooking power	watts watts	4247 1149	CPe	402	CP <sub>n</sub>	Corrected Energy Benchmark to Complete 5L WBT			
ire power Cooking power	watts watts	4247 1149	CPe	402	CP <sub>n</sub>	Corrected Energy Benchmark to Complete 5L WBT			
ire power Cooking power	watts watts	4247 1149	CPe	402	CP <sub>n</sub>	Corrected Energy Benchmark to Complete 5L WBT			
ire power cooking power	watts watts	4247 1149	CPe	402	CP <sub>n</sub>	Corrected Energy Benchmark to Complete 5L WBT			
ire power Cooking power	watts watts	4247 1149	CPe	402	CP <sub>n</sub>	Corrected Energy Benchmark to Complete 5L WBT			
ire power cooking power	watts watts	4247 1149	CPe	402	CP <sub>n</sub>	Corrected Energy Benchmark to Complete 5L WBT			
ire power Cooking power	watts watts	4247 1149	CPe	402	CP <sub>n</sub>	Corrected Energy Benchmark to Complete 5L WBT			
ire power Cooking power	watts watts	4247 1149	CPe	402	CP <sub>n</sub>	Corrected Energy Benchmark to Complete 5L WBT			

- Same sheet we've been looking at (tab circled)

-This is the section of the sheet that contains typical fuel use and efficiency calculations from the WBT spreadsheet

-These calculations include the energy contained in the char

-Next are the results with the char energy excluded . . .

1	AM	AN	AO	AP	AQ	AR	AS	AT
I	CHAR ENERGY EXCLUDED		COLD START	HOT START	CHAR ENERGY	EXCLUDED		SIMMER
	Calculations/Results	Units	data	data	Calculations/Res		Units	data
	Fuel consumed (moist)	9	530.7	684.9	Fuel consumed of	during the simmer phase (mo	g	434.4
	Adjusted net change in char during test	g	0.0	0.0	Adjusted net cha	nge in char during test phase	g	0.0
	Equivalent dry fuel consumed	g	489.6	631.8	Equivalent dry fue	el consumed	g	400.7
	Water vaporized from all pots	g	146.5	215.9	Water vaporized		9	712.0
	Effective mass of water boiled	g	4427.4	4771.9	Water remaining	at end of simmer - All Pots	9	4047.5
	Time to boil Pot # 1	min	27.00	24.00	Time of simmer		min	30.45
1	Temp-corr time to boil Pot # 1	min	27.68	23.29	Burning rate		g/min	13.2
1	Thermal efficiency	%	20.7%	18.1%	Specific fuel cons	sumption	g/liter	99.0
1	Burning rate	g/min	18.1	26.3	Firepower		watts	2868
1	Specific fuel consumption	g/liter	110.6	132.4	Turn down ratio			1.48
1	Temp-corr sp fuel consumption	g/liter	113.3	128.5	Specific Energy C	Consumption	kJ/liter	1823
1	Temp-corr sp energy consumpt.	kJ/liter	2087	2365	Energy in char / E	nergy in equiv dry fuel	%	29%
]	Fire power	watts	4247	5871				
1	Cooking power	watts	1149	1462				
1	Energy in char / Energy in equiv dry fuel	%	24%	27%				
I								
			=	results affected by	excluding char energy			
				_				
4	Summary CS-Result HS-Result	lt / Simmer-I	Result General In	nformation	Test-2 Test-8 T	est-4 / Test-5 / Test-6		

- Same sheet (tab circled) scrolled to right
- Added calculations for Char Energy Excluded

- These results apply ONLY if char (remaining at the end of the burncycle) is discarded or is used for a different purpose (such as for biochar)

- Energy in remaining char is not credited in thermal efficiency and fueluse calculations

- Orange-shaded cells - results affected by excluding char energy

4 T	U	V	W	Х	Y	Z	A AB	AC	AD	AE	A	AG	AH	AJ
3 4	Values used in calculations of emissions	_	COLD START		HOT START		SIMMER TEST (			550 50 0UU		100 700		
¥ 5	(below)	Units	data	label	data	label	SIMMERTEST	CALCOLAT	IONS DIF	FERFROMP	IGHFU	WERTES	Units	data
	H2O start temp correction factor	Units	1.025	label	0.970	label			_		_		Units	uata
7	Effective volume of water boiled	L	4.427		4.772		Remaining volu	mo of water	r of the or	d offert			liter	4.048
3	Fuel Mass (moist)	kg	0.531		0.685		Fuel Mass (moi		i atuie ei	iu or test			Kg	0.434
9	Equivalent dry fuel consumed	kg	0.374		0.459		Equivalent dry ft		ed.				Kg	0.285
)	Equivalent dry fuel energy	MJ	6.879		8.454		Equivalent dry fo		ieu				MJ NJ	5 240
1	Energy delivered to pot(s)	MJ	1.862	Ep.e	2.106	Eph	Equivalent dry it	uerenergy					mj	5.240
2	Duration of test	hr	0.450	C-0,0	0.400	CD,h	Duration of test						hr	0.507
3	Duranon or rest		0.430		0.400		Duration of test		_					0.501
4	Air Pollutant Emissions													
5	THC total mass	9	1.23		0.76		THC total mass						9	0.65
6	Temp corr THC total mass	9	1.27		0.74									
7	THC per effective volume of water boiled	g/L	0.29		0.16		THC per water r	remaining (a	at end of t	est)			g/L	0.16
8	THC per fuel mass (moist)	g/kg	2.33		1.12		THC per fuel ma	ass (moist)	)				g/kg	1.49
9	THC per fuel mass (equiv. dry fuel basis)	g/kg	3.30		1.66		THC per fuel ma	ass (equiv.	dry fuel ba	asis)			g/kg	2.27
0	THC per fuel energy	g/MJ	0.18		0.09		THC per fuel en	iergy					g/MJ	0.12
1	THC per energy delivered to pot	g/MJ	0.66		0.36									
22	THC per time	g/hr	2.74		1.91		THC per time						g/hr	1.27
23	CO total mass	g	7.24		5.02		CO total mass						9	3.83
24	Temp corr CO total mass	9	7.42		4.87									
25	CO per effective volume of water boiled	g/L	1.68		1.02		CO per water re	maining (at	t end of te	st)			g/L	0.95
26	CO per fuel mass (moist)	g/kg	13.64		7.33		CO per fuel ma:	ss (moist)					g/kg	8.83
27	CO per fuel mass (equiv. dry fuel basis)	g/kg	19.38		10.93		CO per fuel ma:	ss (equiv. di	ry base)				g/kg	13.47
28	CO per per fuel energy	gMJ	1.05		0.59		CO per fuel ene	rgy					g/MJ	0.73
29	CO per energy delivered to pot	g/MJ	3.89		2.38									
30	CO per time	g/hr	16.09		12.55		CO per time						g/hr	7.55
31	CH4 total mass	9	0.27		0.11		CH4 total mass	1					9	0.22
32	Temp corr CH4 total mass	9	0.27		0.11									
33	CH4 per effective volume of water boiled	g/L	0.06		0.02		CH4 per water r	remaining (a	at end of t	lest)			g/L	0.06
34	CH4 per fuel mass (moist)	g/kg	0.50		0.16		CH4 per fuel ma						g/kg	0.52
35	CH4 per fuel mass (equiv. dry fuel basis)	g/kg	0.71		0.24		CH4 per fuel ma		dry base)				g/kg	0.79
36	CH4 per fuel energy	g/MJ	0.04		0.01		CH4 per fuel en	iergy					g/MJ	0.04
37	CH4 per energy delivered to pot	g/MJ	0.14		0.05									
38	CH4 per time	g/hr	0.59		0.28		CH4 per time						g/hr	0.44
39	NOx total mass	g	0.31		0.29		NOx total mass						9	0.30
10	Temp corr NOx total mass	g	0.31		0.28									
\$1	NOx per effective volume of water boiled	g/L	0.07		0.06		NOx per water n		at end of t	est)			g/L	0.07
	NOx per fuel mass (moist)	g/kg	0.58		0.42		NOx per fuel ma						g/kg	0.69
•	H Summary CS-Result HS-Result S	Simmer-Result	🖉 General Infor	mation 🔬	Test-1 Test-2	2 / Test-	3 Test-4 / Tes	st-5 🖉 Test	6					

- Still same sheet scrolled down and to the left (tab circled)
- Added (blue-shaded areas)

-Results for emissions for this test replication

-Some of these values are used in the IWA Tier evaluations, but many others are interesting/important to us (at the EPA), but are not currently included in the stove evaluations as outlined by the current IWA

AM AM	AN	AO	AP	AQ	AR	AS	AT
1							
2		= results affecte	ed by excluding char	energy			
		COLD START	HOT START	CHAR ENERG	SY EXCLUDED		SIMMER
5 Calculation Factors	Units	data	data	OTIVIT ENERG			data
6 H2O start temp correction factor		1.025	0.970				-
7 Effective volume of water boiled	L	4.427	4,772	Remaining volume	of water at the end of test		4.048
8 Fuel Mass (moist)	kg	0.531	0.685	Fuel Mass (moist)			0.434
9 Equivalent dry fuel consumed	kg	0.490	0.632	Equivalent dry fuel of	consumed		0.401
Equivalent dry fuel energy	MJ	9.013	11.632	Equivalent dry fuel			7.378
1 Energy delivered to pot(s)	MJ	1,862	2,106				
2 Duration of test	hr	0.450	0.400	Duration of test			0.507
3							
14							
15 THC total mass	g	1.23	0.76	THC total mass			0.65
6 Temp corr THC total mass	g	1.27	0.74				
7 THC per effective volume of water boiled	g/L	0.29	0.16	THC per water rem	aining (at end of test)		0.16
8 THC per fuel mass (moist)	g/kg	2.33	1.12	THC per fuel mass			1.49
9 THC per fuel mass (equiv. dry fuel basis)		2.52	1.21		(equiv. dry fuel basis)		1.61
0 THC per fuel energy	g/MJ	0.14	0.07	THC per fuel energ			0.09
THC per energy delivered to pot	g/MJ	0.66	0.36				
22 THC per time	g/hr	2.74	1.91	THC per time			1.27
23 CO total mass	g	7.24	5.02	CO total mass			3.83
24 Temp corr CO total mass	9	7.42	4.87				
CO per effective volume of water boiled	g/L	1.68	1.02	CO per water remain	ining (at end of test)		0.95
CO per fuel mass (moist)	g/kg	13.64	7.33	CO per fuel mass (	(moist)		8.83
27 CO per fuel mass (equiv. dry fuel basis)	g/kg	14.79	7.94	CO per fuel mass (	(equiv. dry base)		9.57
28 CO per per fuel energy	g/MJ	0.80	0.43	CO per fuel energy			0.52
29 CO per energy delivered to pot	g/MJ	3.89	2.38				
30 CO per time	g/hr	16.09	12.55	CO per time			7.55
31 CH4 total mass	9	0.27	0.11	CH4 total mass			0.22
2 Temp corr CH4 total mass	g	0.27	0.11				
3 CH4 per effective volume of water boiled	g/L	0.06	0.02	CH4 per water rem	aining (at end of test)		0.06
♦ H Summary CS-Result HS-Result	sult 📈 Simmer-Re	sult 🏑 General I	Information / est-:	1 Test-2 Test 3	Test-4 / Test-5 / Test-6	(	

- Scrolled to the right on same sheet (tab circled)
- Added calculations for emissions for Char Energy Excluded
- These results apply ONLY if char is discarded or is used for a different purpose (such as for biochar)
- Energy in remaining char is not credited in emissions calculations
- Orange-shaded cells results affected by excluding char energy

4	AQ AR	AS	AT	AU	AV	AW	AX	AY	AZ	BA
1										
2										
3	Wood - Red Oak (Quercus I	Rubra)								
4	BATCH #	1	1	2	3	4	5			
5	Laboratory	G	S	S	S	S	S			
6	BASIS	dry		dry	dry	dry	dry	Average	Std. Dev.	C
7	VOLATILE	86,60%		87.52%	87.43%	86.82%	86.98%	87.07%	0.39%	0.00
8	FIXED CARBON	12.31%		12.12%	12.28%	12.94%	12.41%	12.41%	0.31%	0.0
9	ASH	1.09%		0.36%	0.29%	0.24%	0.61%	0.52%	0.35%	0.6
10	SULFUR	<0.5%		0.02%	0.01%	0.01%	0.28%	0.07%	0.12%	1.62
11	CARBON	49.44%		49.59%	49.41%	49.60%	49.54%	49.52%	0.09%	0.00
12	HYDROGEN	5.92%		6.06%	5.97%	5.95%	6.22%	6.10%	0.15%	0.02
13	NITROGEN	<0.5%		3.90%	0.48%	0.37%	0.04%	1.20%	1.81%	1.5
14	OXYGEN	43.54%		43.58%	43.84%	43.83%	43.31%	43.62%	0.22%	0.00
15	BTU/LB		8176	8484	8432	8440	8349	8376	122	0.0
16	HHV (kJ/kg)		19017	19734	19613	19631	19420	19483	284	0.0
17	LHV (kJ/kg; calc'd)		17645	18411	18310	18333	18062	18152	312	0.0
18	MAF BTU/LB			8515	8457	8460	8397	8457	48	0.0
19	LBS OF SO2 PER MILLION E	BTU		0.05	0.02	0.02	0.67	0.19	0.32	1.6
20										
21	Charcoal									
22	BATCH #	1	1	1	1					
23	Laboratory	G	S	S	S					
24	BASIS	dry								
25	VOLATILE	19.59%								
26	FIXED CARBON	76.16%								
27	ASH	4.25%								
28	SULFUR	0.15%								
29	CARBON	80.75%								
30	HYDROGEN	2.90%								
31	NITROGEN	0.74%								
32	OXYGEN	10.89%				Average	Std. Dev.	CV		
33	BTU/LB		13076	12651	13263	12997	313.618	0.024		
34	HHV (kJ/kg)		30415	29426	30850	30230	729.476	0.024		
35	LHV (kJ/kg; calc'd)		29782	28793	30217	29597	729.476	0.025		
36								1		

-Return to tour of the enhancements and modifications made in the EPA spreadsheet

-Now moved to Fuel Info sheet (tab circled)

- Includes information from "Calorific values" tab on WBT spreadsheet (not shown in this slide)

- Includes additional fuel analysis results (partially shown) from current round of stove testing

-All analyses done by external, independent labs

4 B/ 5 La 6 B/ 7 8 9 9 10 C/ 11 C/ 13 14 14 15 16 HI 17 LF 18 19 20 20 21 22 23 22 24 25 26 27	Vood - Red Oak (Quercus Rubra ATCH # aboratory ASIS SCATLE VERD CARBON ARBON ARBON TROCERS VYCEN HV (KJ/kg)	a) 1 G dry 49.44%	1 S	2 S ary 49.59%	3 S dry 49.41%	4 S dry 49.60%	5 S dry	Average	Std. Dev.	0.00
2 W 3 W 4 BJ 5 La 6 BJ 7 T 10 C 11 C 12 C 13 C 14 O 15 C 16 H 17 L 18 C 19 20 C 21 C 22 23 C 24 C 25 C 26 C 27 C 27 C 27 C 27 C 27 C 28 C 29 C 20	ATCH # Aboratory ASIS ASIS ACC CAREON SECONS ARBON InternaConstruction ARBON HY (KJ/kg)	1 G dry 49.44%		S ary 49.59%	S ary 49.41%	S dry 12.94% 0.24%	S dry	87.07% 12.41%	0.39%	0.00
3         W           4         By           5         Lat           6         B/           7         7           9         10           10         11           12         13           13         14           15         HI           16         HI           17         LF           18         20           21         22           23         24           24         25           26         27	ATCH # Aboratory ASIS ASIS ACC CAREON SECONS ARBON InternaConstruction ARBON HY (KJ/kg)	1 G dry 49.44%		S ary 49.59%	S ary 49.41%	S dry 12.94% 0.24%	S dry	87.07% 12.41%	0.39%	cv
4 B/ 5 La 6 B/ 7 8 9 9 10 C/ 11 C/ 13 14 10 11 12 11 13 14 14 10 19 20 20 21 21 22 23 24 24 25 26 27	ATCH # Aboratory ASIS ASIS ACC CAREON SECONS ARBON InternaConstruction ARBON HY (KJ/kg)	1 G dry 49.44%		S ary 49.59%	S ary 49.41%	S dry 12.94% 0.24%	S dry	87.07% 12.41%	0.39%	0.00
5 La 6 By 7 1 10 1 11 Cr 12 1 11 Cr 13 1 14 0 15 1 15 1 16 Hi 17 LF 19 20 1 20 2 21 0 22 2 23 2 24 2 25 26 27	aboratory ASIS ASIC CARBON ARBON ARBON TOPOCOSTI TROCEN YYCEI	G dry 49.44%	S	S ary 49.59%	S ary 49.41%	S dry 12.94% 0.24%	S dry	87.07% 12.41%	0.39%	0.00
6 B/ 7 7 9 9 10	ASIS DEATLE VED CARBON ARBON TROUGH TROUGH TROUGH HV (KJ/kg)	49.44%		49.59%	49.41%	dry 88.82% 12.94% 0.24% 0.01%	85.98% 12.41%	87.07% 12.41%	0.39%	0.00
8 9 9 110 C/12 111 C/12 111 111 111 111 111 111 111 111 111	NED CARBON ARBON ARBON TROCEN YYCEH HV (KJ/kg)	49.44%		49.59%	49.41%	86.82% 12.94% 0.24% 0.01%		87.07% 12.41%	0.39%	
9 10 11 11 13 13 14 15 16 HH 17 LH 18 20 21 22 23 24 25 26 27	ARBON TROCEN TROCEN HV (KJkg)	49.44%		49.59%	49.41%	0.24%				
10 CA 11 CA 12 CA 13 CA 14 CA 15 CA 16 HH 17 LH 18 CA 19 CA 20 CA 21 CA 22 CA 23 CA 24 CA 25 CA 26 CA 27 CA 27 CA 27 CA 28 CA 29 CA 20	ARBON HV (kJ/kg)	49.44%		49.59%	49.41%	0.01%				
111 C/ 12 13 14 15 16 HH 17 LH 18 19 20 21 22 23 23 24 22 23 23 24 25 26 27	ARBON TERCOSEN TROOGEN TROOGEN THE B HV (kJ/kg)	5.92%		49.59%	49.41%					
12 13 13 14 15 15 16 HH 17 LH 18 20 20 21 22 23 23 24 25 26 27 28	YDROGEN TROGEN XYGEN TUT E HV (kJ/kg)	5.92%		8.065		40 60%				
13 14 15 16 Hi 17 LH 18 19 20 21 22 23 24 25 26 27	TROGEN XYGEN THTE HV (kJ/kg)				and the second se	49.00%	49.54%	49.52%	0.09%	0.00
14         0           15         -           16         HI           17         LI           18         -           20         -           21         -           22         -           23         -           24         -           25         -           26         -           27         -	XYGEN TULB HV (kJ/kg)					5.95%	6.22%	8,16%	0.15%	0.02
15 H 16 H 17 LF 18 19 20 21 22 23 22 23 24 25 26 27 4	TU/LE HV (kJ/kg)									
16 HI 17 LF 18 19 20 21 22 23 23 24 25 26 27 4										
17         LH           18         4           19         20           21         21           22         23           24         23           25         26           27         4			8176	8484	8432	8440	8349	8376	122	0.01
18         19           19         19           20         21           21         22           23         23           24         39           25         40           26         43           27         44			19017	19734	19613	19631	19420	19483	284	0.01
19 20 21 22 23 24 25 26 27 4	HV (kJ/kg; calc'd)		17645	18411	18310	18333	18062	18152	312	0.01
20 21 22 23 24 25 26 27 4	AF BTU/LB			8515	8457	8460	8397	B457	48	0.00
21 0 22 8 23 2 24 8 25 2 26 8 27 4										
22 8 23 2 24 8 25 2 26 2 27 4										
23 24 8 25 26 27 48										
24 Bi 25 26 27 AS										
25 90 26 81 27 43										
26 27										
27 AS										
35 LH						29597	729.470			

-Same sheet (Fuel Info; tab circled)

-We have had all 5 'batches' of the wood fuel we're using analyzed

-Each 'batch' is made of an entire log (5 different trees, not all purchased at the same time)

-Note consistent values for 5 batches of wood fuel

-Both C-content and energy content

-Tells us that, at least regionally, the composition of this fuel is very consistent

AG	AR AR	AS	AT	AU	AV	AW	AX	AY	AZ	B
1										
2		-		-				ði	_	
3										
4										
5										
6										
7										
8										
9										
10										
11										
12										
13										
14										
15										
16										
17										
18										
19										
20										
21	Charcoal									
22	BATCH#	1	1	1	1					
23	Laboratory	G	S	S	S					
24	BASIS	dry								
25	VOLATILE	19.59%								
26	FIXED CARBON	76.16%								
27	ASH	4.25%								
28	SULFUR	0.15%								
29	CARBON	80.75%								
30	HYDROGEN	2.90%								
31	NITROGEN	0.74%								
32	OXYGEN	10.89%				Average		CV		
33	BTU/LB		13076	12651	13263	12997	313.618	0.024		
34	HHV (kJ/kg)		30415	29426	30850	30230	729.476	0.024		
35	LHV (kJ/kg; calc'd)		29782	28793	30217	29597	729.476	0.025		
36	Simmer-Result General Informatio	n Test-1	Test-2 / T		4 Test-5		el Info	est-1-data	Test-2-	

-Same sheet (Fuel Info; tab circled)

-We have 1 large 'batch' of charcoal

-Purchased many commercially-available bags from the same supplier & combined into one batch

-Took 3 random samples from different parts of the batch...

A	Q AR	AS	AT	AU	AV	AW	AX	AY	AZ	B
1										
2										_
3										
4										
5										
6										
7										
8										
9										
10										
11										
12										
13										
14										
15										
16										
17										
18										
19										
20										
21	Charcoal									
22	BATCH#	1	1	1	1					
23	Laboratory	G	S	S	S					
24		dry								
25										
26										
27										
28	SULFUR	0.15%			_					
29	CARBON	80.75%								
30										
31										
32										
33	BTU/LB		13076	12651	13263	12997	313.618	0.024		
34	HHV (kJ/kg)		30415	29426	30850	30230	729.476	0.024		
35	LHV (kJ/kg; calc'd)		29782	28793	30217	29597	729.476	0.025		
36	H / Simmer-Result / General Informat	1- 1-	/m		1 1	6				

-Same sheet (Fuel Info; tab circled)

-Took 3 random samples from different parts of the batch for analysis -Note consistent values for charcoal fuel from the same batch

	AQ	AR	AS	AT	AU	AV	AW	AX	AY	F
1										
on 55	-	Remaining char (from wood-fuel	ed stoves d	lesigned to	produce	remaining	char)			-
56		Stove (end of test phase)		PekoPe (C						
57		Laboratory	S	S	S					
58		BASIS	dry	dry	dry	Average	Std. Dev.	CV		
59		VOLATILE	3.01%	12.38%	6.31%	7.23%	4.75%	0.657		
60		FIXED CARBON	96.03%	87.05%	92.75%	91.94%	4.54%	0.049		
61		ASH	0.96%	0.57%	0.94%	0.82%	0.22%	0.267		
62		SULFUR	0.01%	0.01%	0.01%	0.01%				
63		CARBON	94.97%	87.76%	93.01%	91.91%	3.73%	0.041		
64		HYDROGEN	1.28%	1.97%	0.81%	1.35%	0.58%	0.431		
65		NITROGEN	0.50%	0.42%	1.04%	0.65%	0.34%	0.516		
66		OXYGEN	2.28%	9.27%	4.19%	5.25%	3.61%	0.689		
67		BTU/LB	14462	13829	14124	14138	317	0.022		
68		HHV (kJ/kg)	33639	32166	32852	32886	737	0.022		
69		LHV (kJ/kg; calc'd)	33379	31766	32688	32611	809	0.025		
70		MAF BTU/LB	14602	13908	14258	14256	347	0.024		
71		LBS OF SO2 PER MILLION BTU	0.01	0.01	0.01	0.01				
72										
73		Remaining char (from wood-fuel	ed stoves d	lesigned to	consume	remaining	char)			
74		Stove (end of test phase)	JikoPoa (C	JikoPoa (H	Greenway	Greenway	(HS-SIM)			
75		Laboratory	S	S	S	S				
76		BASIS	dry	dry	dry	dry	Average	Std. Dev.	CV	
77		VOLATILE	5.46%	4.55%	4.79%	6.87%	5.42%	1.04%	0.192	
78		FIXED CARBON	93.02%	92.18%	93.75%	91.33%	92.57%	1.05%	0.011	
79		ASH	1.52%	2.27%	1.46%	1.80%	1.76%	0.37%	0.21	
80		SULFUR	0.01%	0.02%	0.01%	0.03%	0.02%	0.01%	0.547	
81		CARBON	91.78%	90.80%	92.02%	90.78%	91.35%	0.65%	0.007	
82		HYDROGEN	1.49%	1.60%	1.67%	2.03%	1.70%	0.23%	0.138	
83		NITROGEN	0.36%	0.49%	0.49%	0.50%	0.46%	0.07%	0.145	
84		OXYGEN	4.84%	4.82%	4.35%	4.86%	4.72%	0.25%	0.052	
85		BTU/LB	14232	14354	14420	14304	14328	79	0.006	
86		HHV (kJ/kg)	33104	33387	33541	33271	33326	185	0.006	
87		LHV (kJ/kg; calc'd)	32801	33062	33202	32859	32981	185	0.006	
88		MAF BTU/LB	14452	14687	14634	14566	14585	101	0.007	
89		LBS OF SO2 PER MILLION BTU	0.01	0.03	0.01	0.04	0.02	0.015	0.667	
90		Simmer-Result General Information	n Test-1			4 Test-5	est-6 FL			

- Still on 'Fuel Info' sheet scrolled down (tab circled)
- Fuel analysis results for remaining char (end of test phase)
  - -Analyses also done by independent labs

	AQ AR	AS	AT	AU	AV	AW	AX	AY
ction 1								
55	Remaining char (from wood-fuel					char)		
56	Stove (end of test phase)	Mwoto (CS	PekoPe (C	EcoChula	(CS)		1	
57	Laboratory	S	S	S				
58	BASIS	dry	dry	dry		Std. Dev.		
59	VOLATILE	3.01%	12.38%	6.31%	7.23%	4.75%	0.657	
60	FIXED CARBON	96.03%	87.05%	92.75%	91.94%	4.54%	0.049	
61	ASH	0.96%	0.57%	0.94%	0.82%	0.22%	0.267	
62	SULFUR	0.01%	0.01%	0.01%	0.01%			
63	CARBON	94.97%	87.76%	93.01%	91.91%	3.73%	0.041	
64	HYDROGEN	1.28%	1.97%	0.81%	1.35%	0.58%	0.431	
65	NITROGEN	0.50%	0.42%	1.04%	0.65%	0.34%	0.516	
66	OXYGEN	2.28%	9.27%	4.19%	5.25%	3.61%	0.689	
67	BTU/LB	14462	13829	14124	14138	317	0.022	
68	HHV (kJ/kg)	33639	32166	32852	32886	737	0.022	
69	LHV (kJ/kg; calc'd)	33379	31766	32688	32611	809	0.025	
70	MAF BTU/LB	14602	13908	14258	14256	347	0.024	
71	LBS OF SO2 PER MILLION BTU	0.01	0.01	0.01	0.01			
71 72	LBS OF SO2 PER MILLION BTU	0.01	0.01	0.01	0.01			
	LBS OF SO2 PER MILLION BTU					char)		
72		ed stoves d	lesigned to	consume				
72 73	Remaining char (from wood-fuel	ed stoves d	lesigned to	consume	remaining			
72 73 74	Remaining char (from wood-fuel Stove (end of test phase)	ed stoves d	lesigned to JikoPoa (H	consume	remaining		Std. Dev.	CV
72 73 74 75	Remaining char (from wood-fuel Stove (end of test phase) Laboratory	ed stoves o JikoPoa (C S	lesigned to JikoPoe (H S	consume (Greenwa) S	remaining Greenway S		Std. Dev. 1 04%	CV 0.192
72 73 74 75 76	Remaining char (from wood-fuel Stove (end of test phase) Laboratory BASIS	ed stoves o JikoPoa (C S dry	lesigned to JikoPoe (H S dry	Greenway S dry	remaining Greenway S dry			
72 73 74 75 76 77	Remaining char (from wood-fuel Stove (end of test phase) Laboratory BASIS VOLATILE FIXED CARBON ASH	ed stoves o JikoPoa (C S dry 5:46%	lesigned to JikoPoa (H S dry 4.55%	Greenway S dry 4 79%	Greenway Greenway S dry 6.87%			
72 73 74 75 76 77 78 79 80	Remaining char (from wood-luel Stove (end of test phase) Latoratory BASIS VOLATILE FXED CARBON	ed stoves c JikoPoa (C S dry 5 46% 93.02%	JikoPoa (H S dry 4,55% 92,18%	consume I Greenway S dry 4 79% 93.75%	Greenway Greenway Gry 6.87% 91.33%			
72 73 74 75 76 77 78 79	Remaining char (from wood-fuel Stove (end of test phase) Laboratory BASIS VOLATILE FIXED CARBON ASH	ed stoves c JikoPos (C S dry 5 46% 93.02% 1 52%	lesigned to JikoPoa (H S dry 4 55% 92 18% 2 27%	consume (Greenway S dry 4 79% 93.75% 1.48%	remaining Greenway S dry 6 87% 91 33% 1.80%			
72 73 74 75 76 77 78 79 80	Remaining char (from wood-luel Stove (end of test phase) Laboratory BASIS VOLATLE PRED CAREON ASH SULFUR	ed stoves o JikoPoa (C S dry 5.46% 93.02% 1.52% 0.01%	lesigned to JikoPos (H S dry 4.55% 92.18% 2.27% 0.02%	consume I Greenway S dry 4 795 83,75% 1 48% 0 81%	remaining Greenway S dry 6.87% 91.33% 1.80% 0.03%			
72 73 74 75 76 77 78 79 80 81	Remaining char (from wood-luel Stowe (end of test phase) Laboratory BASIS VOLATLE FIXED CARBON ASH SULFUR CARBON	ed stoves o JikoPoa (C S dry 5.46% 93.02% 1.52% 0.01% 91.78%	lesigned to JikoPoa (H S dry 4.55% 92.18% 2.27% 0.02% 90.80%	consume l Greenway S dry 4 795 83,75% 1 48% 0 81% 92,02%	remaining Greenway S dry 6.87% 91.33% 1.80% 0.03% 90.78%			
72 73 74 75 76 77 78 79 80 81 82	Remaining char (from wood-luel Stove (end of tess phase) Laboratory BASIS VOLATLE FIXED CARBON ASH SULFUR CARBON HYDROGEN	ed stoves o JikoPoa (C S dry 5.46% 93.02% 1.52% 0.01% 91.78% 1.48%	lesigned to JikoPoa (H S dry 4.55% 92.18% 2.27% 0.02% 90.80% 1.60%	consume Greenway 8 dry 4 79% 93.75% 1 46% 0 01% 92.02% 1.87%	remaining Greenway S dry 6.87% 91.33% 1.80% 0.03% 90.78% 2.03%			
72 73 74 75 76 77 78 79 80 81 82 83	Remaining char (from wood-luel Stove (end of test phase) Laboratory Basis VOLATLE FRED CARBON ASH SULFUR CARBON HYDROGEN HITROGEN	ed stoves o JikoPoa (C S dry 5.46% 93.02% 1.52% 0.01% 81.78% 1.40% 0.38%	lesigned to JikoPoa (H S dry, 4.55% 92.18% 2.27% 0.27% 90.80% 1.60% 0.49%	consume Greenway 8 dry 4 79% 93,75% 1 46% 0 01% 92,02% 1 87% 0 49%	remaining Greenway S dry, 6.87% 91.33% 1.80% 0.03% 80.78% 2.03% 0.50%			
72 73 74 75 76 77 78 79 80 81 82 83 84	Remaining char (from wood-luel Stove (end of test phase) Laboratory BASIS VOLATLE FIXED CARBON ASH SULFUR CARBON CARBON HURCOGEN HURCOGEN OXYGEN OXYGEN	ed stoves of JikoPoa (C S dry 5.46% 93.02% 1.52% 0.01% 0.01% 0.1% 1.40% 0.36% 4.84%	tesigned to JikoPoa (H S dry, 4.50% 92.18% 92.18% 9.02% 90.80% 1.80% 0.49% 4.82%	consume Greenway S dry 4 795% 33.75% 1 48% 0 49% 1.87% 0 49% 4.35%	remaining Greenway S dry 6.87% 91.33% 1.80% 0.03% 80.78% 2.03% 0.50% 4.85%			
72 73 74 75 76 77 78 79 80 81 82 83 83 84 85	Remaining char (from wood-luel Stove (end of test phase) Laboratory BASIS VOLATLE VOLATLE FRED CARBON ASH SULFUR CARBON HYDROGEN HYDROGEN HATROGEN OXYGEN BTULLB	ed stoves of JikoPos (C S dry 5 46% 93.02% 1 52% 0.01% 81 78% 1 48% 1 48% 1 48% 1 48% 1 48% 1 48% 1 48%	lesigned to JikoPos (H S dry 4.55% 92.18% 2.27% 0.02% 90.60% 1.60% 0.49% 4.82% 1.4354	consume Greenway S dry 4 79% 83 75% 1 40% 0 01% 92 02% 1 67% 0 49% 4 35% 1 4420	remaining Greenway S dry 6 87% 91 33% 1.80% 0.03% 80.78% 2.03% 0.50% 4.85% 14304			
72 73 74 75 76 77 78 79 80 80 81 82 83 84 85 86	Remaining char (from wood-luel Stove (end of test phase) Laboratory BASIS VOLATLE FRED CARBON ASH SULFUR CARBON CARBON HITROGEN NITROGEN DXYGEN BTUILB HRV (Raing)	ed stoves c JikoPoa (C S dry 5.46% 93.02% 1.52% 0.01% 81.78% 1.48% 0.38% 4.84% 4.84% 4.84% 4.84% 4.84% 4.38%	lesigned to divoPoa (H S dry 4 55% 92.18% 2 27% 0 02% 90.60% 1.80% 0.482% 1.4354 33387	consume (Greenway 4 79% 83 75% 1 48% 0 01% 92 02% 1 67% 0 49% 4 35% 1 4420 33541	remaining Greenway S dry 8.87% 91.33% 1.80% 0.03% 80.78% 2.03% 0.53% 4.85% 14304 33271			

-We have separated:

-Remaining char from wood-fueled, designed to PRODUCE char

A	AR AR	AS	AT	AU	AV	AW	AX	AY	
1									
55	Remaining char (from wood-fuel								
56	Stove (end of test phase)								
57	Laboratory								
58	BASIS								
59	VOLATILE								
60	FIXED CARBON								
61	ASH								
62	SULFUR								
63	CARBON								
64	HYDROGEN								
65	NITROGEN								
66	OXYGEN								
67	BTULB								
68	HHV (kURp)								
69	LHV (kJ/kg; calc'd)								
70	MAF BTULB								
71	LBS OF SO2 PER MILLION BTU								
72				1					
73	Remaining char (from wood-fuel	ed stoves	lesigned to	consume	remaining	char)			
74	Stove (end of test phase)		JikoPoa (H						
75	Laboratory	S	S	S	S	(inc shirt)			
76	BASIS	dry	dry	dry	dry	Average	Std. Dev.	CV	
77	VOLATILE	5.46%	4.55%	4.79%	6.87%	5.42%	1.04%	0.192	
78	FIXED CARBON	93.02%	92.18%	93.75%	91.33%	92.57%	1.05%	0.011	
79	ASH	1.52%	2.27%	1.46%	1.80%	1.76%	0.37%	0.21	
80	SULFUR	0.01%	0.02%	0.01%	0.03%	0.02%	0.01%	0.547	
81	CARBON	91,78%	90.80%	92.02%	90.78%	91.35%	0.65%	0.007	
82	HYDROGEN	1.49%	1.60%	1.67%	2.03%	1.70%	0.23%	0.138	
83	NITROGEN	0.36%	0.49%	0.49%	0.50%	0.46%	0.07%	0.145	
84	OXYGEN	4.84%	4.82%	4.35%	4.86%	4.72%	0.25%	0.052	
85	BTU/LB	14232	14354	14420	14304	14328	79	0.006	
86	HHV (kJ/kg)	33104	33387	33541	33271	33326	185	0.006	
87	LHV (kJ/kg; calc'd)	32801	33062	33202	32859	32981	185	0.006	
	MAF BTU/LB	14452	14687	14634	14566	14585	101	0.007	
88 89	LBS OF SO2 PER MILLION BTU	0.01	0.03	0.01	0.04	0.02	0.015	0.667	

-We have separated:

-Separately, wood-fueled, designed to CONSUME char

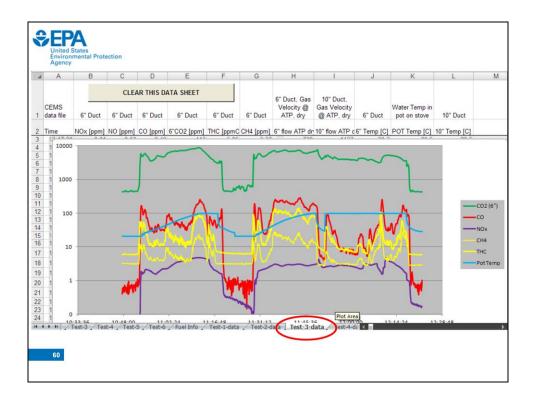
-Designed to operate differently, not good to lump together

1         Remaining char (from wood-fueled stoves designed to produce remaining char)		AQ	AR	AS	AT	AU	AV	AW	AX	AY	A
56         Remaining char (from wood-fueled stoves designed to produce remaining char)	1										
56         Stove (end of test phase)         Mwoto (CS PekoPe (C EcoChula (CS))           57         Laboratory         S         S         S           58         BASIS         dry         dry         dry         dry         dry           59         VOLATILE         3.01%         12.38%         6.31%         7.23%         4.75%         0.657           60         Access and transmitted interest of the construct of the consthe construct of the consthe construct of the construct			Remaining char (from wood-fuel	ed stoves d	lesigned to	produce	remaining	char)			_
57         Laboratory         S         S         S         Average         Std. Dev.         CV           58         BASIS         dry         dry <td< td=""><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></td<>											
59         VOLATILE         3.01%         12.38%         6.31%         7.23%         4.75%         0.657           60         Attraction of the phase)	57										
59         VOLATILE         3.01%         12.38%         6.31%         7.23%         4.75%         0.657           60         Machine Landson         Machine Landson </td <td>58</td> <td></td> <td>BASIS</td> <td>dry</td> <td>dry</td> <td>dry</td> <td>Average</td> <td>Std. Dev.</td> <td>CV</td> <td></td> <td></td>	58		BASIS	dry	dry	dry	Average	Std. Dev.	CV		
61         ASM         0.45%         0.45%         0.45%         0.25% <th0.25%< th="">         0.25%         0.25%</th0.25%<>	59		VOLATILE	3.01%	12.38%	6.31%					
62         Sector         61355         61355         61355         61355           63         CARBON         94.97%         87.76%         93.01%         91.91%         3.73%         0.041           64         Microsoft         535         62.5         53.5         53.5         53.5           66         Microsoft         535         53.5         53.5         53.5         53.5           67         FildLB         535.5         53.5         53.5         53.5         53.5           68         Histopath         535.5         53.5         53.5         53.5         53.5           70         Accord for the base         535.5         53.5         53.5         53.5         53.5           71         Exporting         SixoP (end of test phase)         JikoPoa (C JikoPoa (H Greenway Greenway (HS-SIM))         54.2%         10.4%         0.192           74         Stove (end of test phase)         JikoPoa (C JikoPoa (H Greenway Greenway (HS-SIM))         54.2%         10.4%         0.192           76         BASIS         dry         dry         dry         dry         Average         Std. Dev.         CV           77         VOLATILE         54.6%         4.55%         4.	60		FIXED CARBON	98 03%	87.05%	92.75%	91.94%	.4 54%	0.049		
63         CARBON         94.97%         87.76%         93.01%         91.91%         3.73%         0.041           64         Intractantial         1.02%	61										
64         D128203280         D238	62										
86         M1202021h         2.20%         2.40%         1.44%         0.25%         0.24%         0.25%         0.24%         0.25%         0.22%         0.25%         0.22%         0.25%         0.22%         0.25%         0.25%         0.22%         0.25% <t< td=""><td>63</td><td></td><td>CARBON</td><td>94.97%</td><td>87.76%</td><td>93.01%</td><td>91.91%</td><td>3.73%</td><td>0.041</td><td></td><td></td></t<>	63		CARBON	94.97%	87.76%	93.01%	91.91%	3.73%	0.041		
86         D21/02/14         22/25         41/25         22/25 <t< td=""><td>64</td><td></td><td>HYDROGEN</td><td>1.28%</td><td>1.97%</td><td>0,81%</td><td>1.35%</td><td>0.58%</td><td>0.431</td><td></td><td></td></t<>	64		HYDROGEN	1.28%	1.97%	0,81%	1.35%	0.58%	0.431		
67         B10LB         14520         14520         14524         14554         1455         14554         1455         1455         1455         1455         1455         1455         1455	65										
68         Ferring Lange         2020	66										
69         And Particle         6970         Add Particle         60700 </td <td>67</td> <td></td>	67										
70         Mail Status         14000         14000         1400	68										
71         Description         Consume remaining char           72         Remaining char (from wood-fueled stoves designed to consume remaining char)         1           73         Remaining char (from wood-fueled stoves designed to consume remaining char)         1           74         Stove (end of test phase)         JikoPoa (C JikoPoa (H Greenway, Greenway	69										
72         Remaining char (from wood-fueled stoves designed to consume remaining char)         Normal State	70										
73         Remaining char (from wood-fueled stoves designed to consume remaining char)         Image: Consumer remaining char)         Image: Consumar)         Image: Consumar)         Image: Co	71										
74         Stove (end of test phase)         JikoPoa (C JikoPoa (H Greenway Greenway (HS-SIM))           76         Laboratory         S         S         S         S           76         BASIS         dry         dry         dry         dry         dry         Average         Std. Dev.         CV           77         VOLATILE         5.46%         4.55%         4.79%         6.87%         5.42%         1.04%         0.192           78         80         81         CARBON         91.78%         90.80%         92.02%         90.78%         91.35%         0.65%         0.007           83         64         <	72						10				
76         Laboratory         S         S         S         S         S         S         Average         Std. Dev.         CV           76         BASIS         dry         dry </td <td>73</td> <td></td> <td>Remaining char (from wood-fuel</td> <td>led stoves d</td> <td>lesigned to</td> <td>consume</td> <td>remaining</td> <td>char)</td> <td></td> <td></td> <td></td>	73		Remaining char (from wood-fuel	led stoves d	lesigned to	consume	remaining	char)			
76         BASIS         dry         dry         dry         dry         dry         dry         Average         Std. Dev.         CV           77         VOLATILE         5.46%         4.55%         4.79%         6.87%         5.42%         1.04%         0.192           78	74		Stove (end of test phase)	JikoPoa (C	JikoPoa (H	Greenway	Greenway	(HS-SIM)			
77         VOLATILE         5.46%         4.55%         4.79%         6.87%         5.42%         1.04%         0.192           78	75		Laboratory	S	S	S	S				
78         78         78         81         CARBON         91.78%         90.80%         92.02%         90.78%         91.35%         0.65%         0.007           81         CARBON         91.78%         90.80%         92.02%         90.78%         91.35%         0.65%         0.007           82         83         1475         145	76		BASIS	dry	dry	dry	dry	Average	Std. Dev.	CV	
79         AcH         122         142 <th14< th=""> <th14< th=""> <th14< th=""></th14<></th14<></th14<>	77		VOLATILE	5.46%	4.55%	4.79%	6.87%	5.42%	1.04%	0.192	
80         CARBON         91.78%         90.80%         92.02%         90.78%         91.35%         0.65%         0.007           82         HUDROGERI         4.44	78		FIXED CARBON	93.02*	92.18%	93.75%	91.33%	92.57%	1.05%	0.011	
61         CARBON         91.78%         90.80%         92.02%         90.78%         91.35%         0.65%         0.007           82         Marcolasti         4.35%         4.65%         0.01         0.03           83         Marcolasti         4.35%         4.45%         4.45%         0.65%         0.03           84         OXYCEN         4.45%         4.45%         4.45%         4.45%         0.05%         0.05%           85         FULLB         4.45%         4.45%         4.45%         4.45%         0.05%         0.05%           86         Her Lange         4.35%         4.45%         4.45%         4.45%         1.45%         0.05%         0.05%           87         Her Lange         4.35%         4.45%         4.45%         1.45%         0.05%         0.05%           88         Marc Structs         4.45%         4.45%         4.45%         1.45%         0.05%         0.05%	79										
82         HTDROGEN         1-44%         1-87%         2-03%         1-10%         0-25%         0-138           83         INTROGEN         0.385%         0.49%         0.49%         0.49%         0.49%         0.07%         0.145           84         0.02X9EN         4.84%         4.35%         4.45%         4.25%         0.25%         0.025           85         BTULE         1423         1454         14420         14304         14525         79         0.006           86         HHV (kikg calcid)         33042         33642         33271         33291         185         0.006           87         LHV (kikg calcid)         32801         3062         32802         32851         1455         0.007           88         MAF         14452         14452         14654         14555         101         0.007	80		SULFUR	0.01%	0.02%	0.01%	0.0355	0.02%	0.01%	0.547	
83         NITROGEN         0.35%         0.49% <th< td=""><td>81</td><td></td><td>CARBON</td><td>91.78%</td><td>90.80%</td><td>92.02%</td><td>90.78%</td><td>91.35%</td><td>0.65%</td><td>0.007</td><td></td></th<>	81		CARBON	91.78%	90.80%	92.02%	90.78%	91.35%	0.65%	0.007	
84         CXXVGEN         4.84%         4.82%         4.35%         4.89%         4.72%         0.25%         0.052           85         BTULE         14232         14354         14404         14328         79         0.006           86         H4V (kilkg)         33104         3367         33671         33271         53326         185         0.006           87         LHV (kilkg)         33104         3367         33629         32861         185         0.006           87         LHV (kilkg)         33104         3367         34829         32811         185         0.006           88         MAF_BTULE         14452         14667         14535         101         0.007											
86         BTL/LE         14232         14354         14420         14304         14328         79         0.006           86         HHV (kilkg)         33104         3387         33641         33271         33306         185         0.006           87         LHV (kilkg) calc/d)         32801         3062         32802         32861         185         0.006           87         LHV (kilkg) calc/d)         32801         3062         32802         32861         185         0.006           88         MMF BTULES         14452         14634         14636         14586         14595         101         0.007											
86         H+R/ (k,lkg, calc/d)         33104         33367         33641         33271         53328         185         0.006           87         LH-V (k,lkg, calc/d)         32801         30802         32802         32861         32101         185         0.006           88         MAF BTULES         14452         14654         14636         14505         101         0.007											
87         LHV (kilkg, calc/u)         32801         33062         32869         32861         185         0.006           88         MAF BTULE         14452         14667         14534         14585         101         0.007											
88 MAF BTULE 14452 14687 14634 14566 14585 101 0.007											
89 LBS OF SO2 PER MILLION BTU 0.01 0.03 0.01 0.04 0.02 0.016 0.687											
90								9.92	0.015		
	1.1	( ) H	Simmer-Result General Information	on Test-1	1850-2 / 1	est-3 / Test	-4 / Test-5 /	Test-6 FL		t-1-data 🏑	Test-

-Note:

char produced by stoves has higher carbon content (80.7% C vs near-or-above 90%; and lower volatile content:~20% in commercial char coal) than charcoal fuel produced by commercial supplier

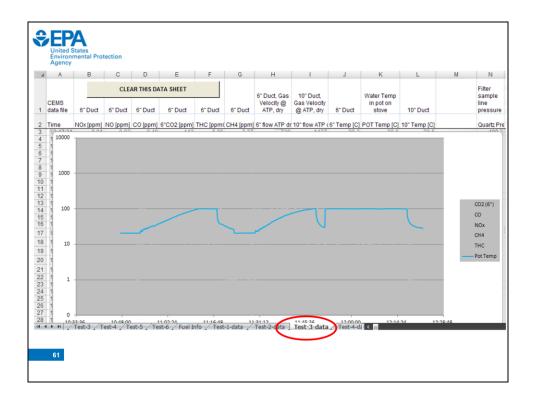
- Fuel analysis results for liquid fuels (kerosene and denatured alcohol) and remaining char from charcoal-fueled stoves also included (not shown – also on 'Fuel Info' sheet)



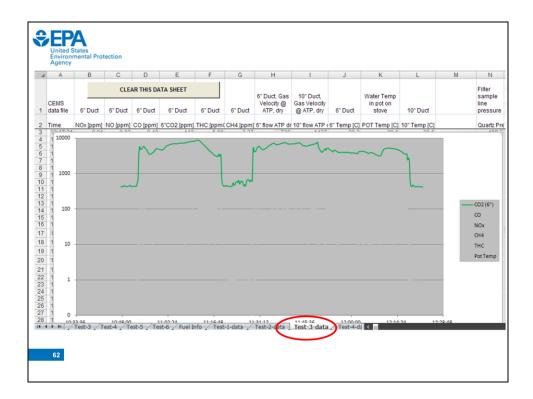
- Now looking at raw data for one test replication (Test 3; tab circled)

- Column headings include identification of 6-inch or 10-inch ducts (primary and secondary dilution tunnels, specific to EPA test facility), the measurement made, and units

- Graph of (some) real-time data is shown for each replication



-Blue line is temperature of water in pot - indicates test phase



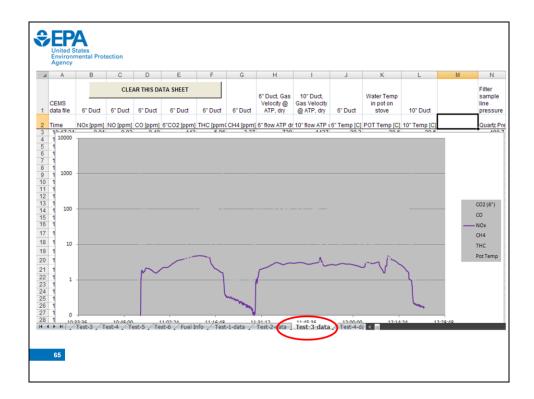
-Green line is (carbon dioxide) concentration – indicates fuel burningrate



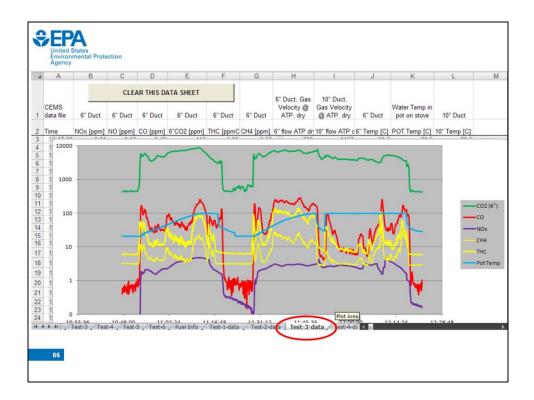
-Red line is CO (carbon monoxide) concentration

	A	В	С	D	E	F	G	Н	1	J	K	L	М	N
			CLE	AR THIS DA	ATA SHEET			6" Duct, Gas	10" Duct,		Water Temp			Filter sample
	CEMS data file	6" Duct	6" Duct	6" Duct	6" Duct	6" Duct	6" Duct	Velocity @ ATP, dry	Gas Velocity @ ATP, dry	6" Duct	in pot on stove	10" Duct		line pressu
ŀ	Time	NOx [ppm]	NO [ppm]	CO [ppm]	6"CO2 [ppm]	THC [ppm	(CH4 [ppm]	6" flow ATP dr	10" flow ATP	6" Temp [C]	POT Temp [C]	10" Temp [C]		Quartz
	1 10 1 1 1 1				/ •••• ./ ••••				~~		Ŵ			NOx CH4 THC Pot Temp
	1 1 1													

-Yellow lines are THC (total hydrocarbon) and CH4 (methane) concentrations



-Purple line is NOX (nitrogen oxides) concentration



- Looking at raw data like this helps us see how measurements fit together, and spot issues

1	A	В	С	D	E	F	G	н	1	J	К	L	M N	0
	CEMS	_	CLE/	AR THIS DA	TA SHEET			6" Duct, Gas Velocity @	10" Duct, Gas Velocity		Water Temp in		Filter sample line	Filter sample line
	data file	6" Duct	6" Duct	6" Duct	6" Duct	6" Duct	6" Duct	ATP, dry	@ ATP, dry	6" Duct	pot on stove	10" Duct	pressure	pressure
											POT Temp [C]			re Teflon Pressure
3	10:51:26	0.03	-0.03	0.61	456	5.90	3.08	735	1433	20.3			243.	
	10:51:31	0.02	-0.02		455	5.91	3.19	732	1441	20.2			244.	
2	10:51:36	0.02	-0.02	0.60	453	6.01	3.17	735	1433	20.2			244.1	
3	10:51:41	0.02	-0.02	0.49	451	5.92	3.20	735	1433	20.3			244.	
	10:51:46	0.03	-0.02	0.64	450	6.03	3.21	738	1433	20.3			244.	
5	10:51:51	0.00	-0.01	0.89	454	5.89	3.12	735	1429	20.3			246.	
5	10:51:56	0.01	-0.02	0.67	459	6.01	3.13	735	1433	20.3			399.3	
7	10:52:01	0.01	-0.01	0.76	461	5.95	3.17	735	1429	20.4			401.	
3	10:52:06	0.02	-0.02	0.69	458	5.99	3.18	735	1433	20.3			401.	
9	10:52:11	0.00	-0.01	0.69	455	6.05	3.19	735	1437	20.3			401.	
)	10:52:16	0.01	-0.01	0.88	454	5.94	3.26	735	1433	20.4			401.	
	10:52:21	0.02	-0.02	1.10	457	6.04	3.23	735	1433	20.3			401.	
2	10:52:26	-0.03	-0.02	0.65	478	6.30	3.30	735	1433	20.3			401.	
5			-0.03											
	10:52:36	0.03		0.77	524	6.07	3.15	735	1437	20.3			394.	
5	10:52:41 10:52:46	0.03	0.00	0.74	574 610	6.74	3.18	735	1433	20.4			389.	
7	10:52:46	0.03	-0.01	0.84	610	12.97	3.15	737	1437	20.6			389.	
8	10:52:51	0.03	-0.01	1.16	778	15.06	3.13	740	1437	21.4			389.	
9	10:52:56	0.05	-0.01	2.34	1290	24.95	4.75	739	1437	22.0			389.	
0	10:53:01	0.05	0.01	8.07	2416	55.62	9.63	741	1444	25.6			389.	
1	10:53:00	0.09	0.02	23.18	3739	39.68	12.21	734	1439	25.0			389.	
2	10:53:16	0.14	0.05	53.54	4890	54.54	9.60	734	1435	28.3			389.	
3	10:53:21	1.08	0.65	106.61	5759	47.07	9.66	732	1433	29.2			389.	
1	10:53:26	1.06	0.67	151.98	6014	40.16	8.59	731	1438	29.8			389.	
5	10:53:31	1.71	0.62	165.02	5683	51.28	9.60	731	1430	30.4			389.	
5	10:53:36	1.87	0.61	166.05	5150	55.16	11.72	728	1434	31.2			389.	
7	10:53:41	1.84	0.50	151.42	4977	44.06	11.32	728	1430	31.7			389.	
3	10:53:46	1.80	0.44	138.48	5095	31.03	7.65	728	1434	31.7			389.	
3	10:53:51	1.74	0.44	133.96	5106	30.27	6.95	732	1434	31.7			389.	
j l	10:53:56	1.56	0.49	123.93	4976	40.06	9.01	730	1435	31.7			389.	
	10:54:01	1.58	0.49	103.60	5012	37.44	8.56	730	1431	31.8			389.	
2	10:54:06	1.62	0.68	89.22	5238	36.32	9.07	730	1431	32.1			389.	
3	10:54:11	1.62	0.68	90.90	5419	40.35	8.77	733	1435	32.2			389.	
	10:54:16	1.71	0.74	98.08	5521	52.39	10.30	736	1439	32.5			389.	
5	10:54:21	1.74	0.76	100.61	5653	53.66	11.95	736	1431	32.8			389.	
	10:54:26	1.71	0.77	103.60	5838	45.53	11.01	736	1435	33.2			389.	
1	10:54:31	1.73	0.76	114.28	5982	43.92	9.09	736	1439	33.6	25.9	22.1	389.3	2 382.0
	10:54:36	1.85	0.86	126.69	6057	46.33	10.63	733	1431	33.9			389.	
3	10:54:41	1.96	0.91	128.11	6090	40.27	9.51	730	1431	34.2	26.0	22.2	389.3	2 381.9
4	P H Te	st-1 / Test	-2 / Test-	3 / Test-4	Test-5 Tes	t-6 / Fuel In	nfo / Test-	1-data / Test	-2-deta Test	-3-data T	est 4-data / Te	st- 1 m		and the second second
C	67									-				
ſ	01													

Same sheet (tab circled)

- scrolled down
- shows columns of raw (unmodified) data

- keeps record of raw data in the same workbook as analysis,

facilitates manual calculations (quality checks)

	BT	BU	BV	BW	BX	BY	BZ	CA	CB	CC	CD	CE	CF	CG
1	SMPS	)												
9														
	Date	Start Time		14.6	15.1	15.7	16.3	16.8	17.5	18.1	18.8	19.5	20.2	:
1	2/12/2013	10:32:07		0	0	0	0	0	0	0	0	0	0	
	2/12/2013	10:34:37		0	0	0			0		0	1	0	
	2/12/2013	10:37:07		0	0	0			0		0	0	0	
	2/12/2013	10:39:37		0	0	0			0		0	3	0	
	2/12/2013	10:42:07		0	0	0			0		0	0	0	
	2/12/2013	10:44:37		0	0	0	0	0	0	0	0	0	0	
	2/12/2013	10:47:08		0	0	0			0	0	0	0	0	
	2/12/2013	10:49:38		0	0	0		0	0	0	0	1	2	
	2/12/2013	10:52:08		0	0	0			0	0	0	1	0	
)	2/12/2013	10:54:38		593	638	653	667	697	717	800	773	807	829	
	2/12/2013	10:57:08		2072	2324	2292	2517	2603	2674	2567	2588	2635	2477	
2	2/12/2013	10:59:38		1098	1049	1033	1090	1096	1036	1084	1058	1085	1046	
	2/12/2013	11:02:08		3213	3551	3529			4186	4331	4658	5115	5244	
	2/12/2013	11:04:38		5385	5590	6076		6864	7072	7243	7373	7438	7335	
	2/12/2013	11:07:08		5207	5182	5298		5158	4985	4790	4275	4077	3791	
	2/12/2013	11:09:38		1363	1424	1349			1337	1206	1179	1185	1062	
	2/12/2013	11:12:08		876	1011	1046		1385	1576	1872	2046	2273	2513	
	2/12/2013	11:14:38		6833	7156	7884			9187	9492	9502	9548	9710	9
	2/12/2013	11:17:08		2353	2594	2580		3211	3573	3759	3738	3787	3969	3
	2/12/2013	11:19:38		142	133	127			98	128	175	126	114	
	2/12/2013	11:22:08		36	56	39		60	50	37	40	52	60	
	2/12/2013	11:24:38		4	8	14			12	10	20	15	11	
	2/12/2013	11:27:08		9	4	3			10	10	10	8	3	
	2/12/2013	11:29:38		396	466	590			1327	1705	2170	2697	3010	
	2/12/2013	11:32:08		1222	1295	1435			1373	1379	1334	1301	1246	
	2/12/2013	11:34:38		3189	3392	3199		3607	3584	3686	3776	3988	4130	4
	2/12/2013	11:37:08		1611	1818	2000	1956	2109 1948	2181 2190	2246	2567	2540 2997	2805 3398	-
	2/12/2013	11:39:38 11:42:08		1208	1424 2202	2593			2190	2442 3631	2655	4130	3398 4380	
	2/12/2013 2/12/2013	11:42:08		1732	2202	2593		2778	2991	3631	3745	4130	4380	
	2/12/2013 2/12/2013	11:44:38		2538	2136	2261		3597	2991	3424	4487	4110	4609	
	2/12/2013	11:47:09		2538	2874 9494	9623			4068	4258	7412	4753	6144	-
	2/12/2013	11:52:09		2646	2580	2537	2403	2370	2315	2147	2320	2298	2295	-
	2/12/2013	11:54:39		3111	2981	2965		2967	2795	2747	2631	2541	2471	
	2/12/2013	11:57:09		4080	4233	4046		3706	3462	3325	3029	2839	2583	
	2/12/2013	11:59:39		5520	5200	4953			3906	3597	3230	2773	2505	-
	2/12/2013	12:02:09		5628	5512	5427			5089	4884	4930	4761	4756	
1	F H	10.01.00	Test-4 Test	1000	Fuel Info	Test-1-data	1007	2000	esi-4-data	2100	2005	0700	0000	

- Still raw data sheet for Test 3 (tab circled; sheet scrolled to the right)

- Shown is raw data for the online PM sizing instrument (SMPS) that was included in graph shown on earlier slide

- Also raw data for:

-aethalometer, black carbon emissions (real-time, 1 s resolution)

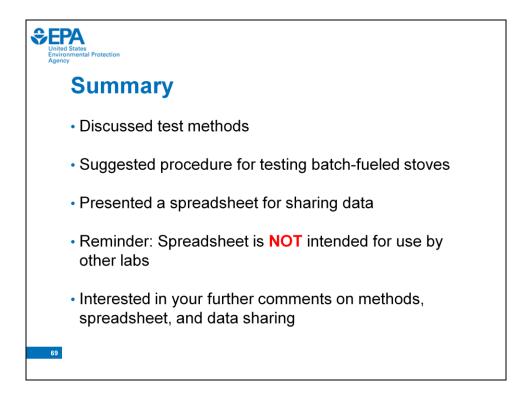
- nephelometer, particle light scattering (real-time, 1 s resolution)

- PASS-3 (photo-acoustic soot spectrometer, 3-wavelength), particle light absorption (real-time, 1 s resolution)

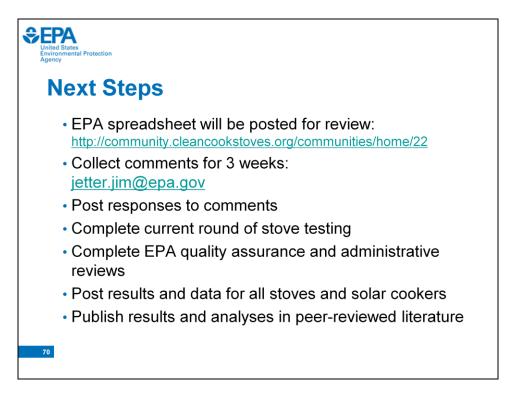
- PM2.5 and EC/OC (elemental carbon/organic carbon) filters (integrated samples, whole test phase)

- SMPS (scanning mobility particle sizer), fine particle size distribution (semi-real-time, 2-2.5 min resolution)

- APS (aerodynamic particle sizer), course particle size distribution (semi-real-time, 20 s resolution)



In summary, we discussed test methods and suggested a procedure for testing batch-fueled stoves. We presented a spreadsheet for sharing data, and one reminder (again) is that the spreadsheet is not intended for use by other testing labs. We are very interested in your further comments on the methods, spreadsheet, and data sharing. At EPA, we have learned so much about stoves and stove testing from many of you – we thank you for sharing your information, knowledge, and ideas.



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Next: Questions
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